DOES NOT CIRCULATE

SCIENCE

UNIVERSITY OF MICHIGAN
MAR 1 1955
MEDICAL LIBRARY

18 MARCH 1955

VOLUME 121 NUMBER 3142

Fifty Years of Boundary-Layer Theory and Experiment: *H. L. Dryden* 375

News and Notes

Southwestern and Rocky Mountain Division 1955 Meeting; and Regular Departments 381

Book Reviews

Effects of Electricity on Muscular Motion; Distribution and Abundance of Animals; Entire Functions; Progress in the Chemistry of Organic Natural Products; Language of Taxonomy; Recent Progress in Hormone Research; Traité de Génétique; Analytic Geometry; Heterocyclic Compounds with Indole and Carbazole Systems; New Books; and Miscellaneous Publications 389

Technical Papers

Preliminary Notes on the Culturing of *Gymnodinium brevis* Davis: *W. B. Wilson* and *A. Collier* 394

Visual Detection of Temperature-Density Discontinuities in Water by Diving: *C. Limbaugh* and *A. B. Rechnitzer* 395

On Some Aspects of Spatial Pattern in Biological Populations: *P. J. Clark* and *F. C. Evans* 397

Direct Recording from the A-V Conducting System in the Dog and Monkey: *A. M. Scher* 398

Dosage Effect of Multiple *Dt* Loci on Mutation of *a* in the Maize Endosperm: *M. G. Nuffer* 399

Communications

Effect of Arasan-Treated Corn on Laying Hens: *P. E. Waibel, B. S. Pomeroy, E. L. Johnson* 401

An Application of Statistics: *F. Sargent, II* 402

Note on a Visible Thermocline: *A. H. Banner* 402

Prevention of Evaporation in Horizontal Strip Ionography: *H. J. McDonald; S. Raymond* 403

Lattice Constants of Pure and Fluoride-Contaminated Ice: *F. K. Truby* 404

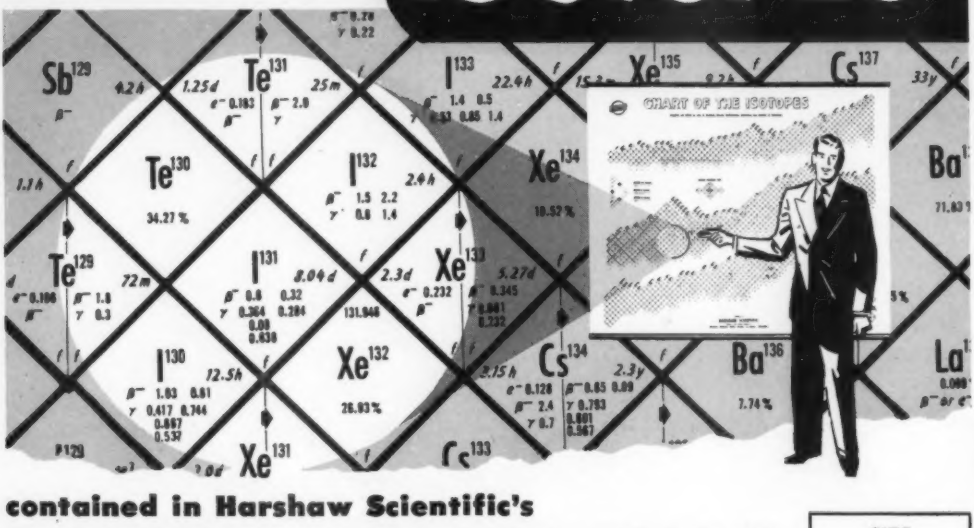
Society of Protozoologists 9A

Meetings & Conferences 16A–19A

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

All the useful information about

ISOTOPES



contained in Harshaw Scientific's COLOR CODED (wall) CHART of the ISOTOPES*

SIZE
5 feet wide
4 feet high

Invaluable as ready reference for teaching or those working with or considering isotopes

Judged by many as the most useful wall chart since the periodic chart of the atoms, the Harshaw Chart of the Isotopes makes available in easy to read and easy to use form ALL the useful information about ISOTOPES.

Eight color codes make possible rapid identification of isotope half-life and nuclear stability.

Every college and university can make excellent use of this chart in their chemistry, physics, biology and biochemistry departments; also all hospitals, medical schools, industrial research and control laboratories who are working with or considering ISOTOPES.

The chart is 5' wide by 4' high and is equipped with metal edges for hanging. Printed on Texoprint, a new plastic impregnated fibre paper developed for navy charts, it is washable, non-creasing and extremely tear resistant. Includes a guide book outlining instructions for reading the chart and summarizes many applications for chart.

H-10950 — Chart of the Isotopes, 1953 Edition, complete with guide book (postage prepaid) Each. . . . . $ 7.50
Outside continental limits of U. S. Rolled in mailing tube (air express prepaid) Each $15.50
Outside continental limits of U. S. folded and without metal edges (postage prepaid) Each . . . . . $ 8.00

THE CHART PROVIDES THE FOLLOWING INFORMATION:

- Element Name — Atomic Mass Data
- Atomic Number — Element Symbol
- Atomic Weight, 1952 Revision
- Thermal Neutron Cross Section
- Stable Isotopes Color Coded in Blue
- Naturally Radioactive Isotopes Color Coded in Green
- Artificially Radioactive Isotopes Coded by Half-life in 6 Colors
- Radioisotope half-life
- Modes of Radioactive Decay
- Radiation Energies in Million electron volts
- Isomeric States
- Isomeric Transitions
- Nuclear Transmutation Code
- Percentage Abundance of Naturally Occurring Isotopes
- Fission Data (thermal fission of U^{235})
- Lithographed in 8 Colors Plus Black and Gray

Corrected to February 1, 1953

Compiled and Edited by JOHN R. BRADFORD, Ph.D. Director Radioisotopes Laboratory, Case Institute of Technology. *International copyright

HARSHAW SCIENTIFIC
Division of the Harshaw Chemical Company

CINCINNATI • CLEVELAND
DETROIT • HOUSTON
LOS ANGELES • PHILADELPHIA

Fifty Years of Boundary-Layer Theory and Experiment

Hugh L. Dryden

National Advisory Committee for Aeronautics, Washington 25, D.C.

THE year 1954 marked the 50th anniversary of the Prandtl boundary-layer theory from which we may date the beginning of man's understanding of the dynamics of real fluids. A backward look at this aspect of the history of the last 50 years may be instructive. This paper (*1*) attempts to compress the events of those 50 years into a few thousand words, to tell in this brief space the interesting story of the development of a new concept, its slow acceptance and growth, its spread from group to group within its country of origin, and its diffusion to other countries of the world.

The original brief paper of Prandtl (*2*) was presented at the Third International Mathematical Congress at Heidelberg in 1904 and published in the following year. It was an attempt to explain the d'Alembert paradox, namely, that the neglect of the small friction of air in the theory resulted in the prediction of zero resistance to motion. Prandtl set himself the task of computing the motion of a fluid of small friction, so small that its effect could be neglected everywhere except where large velocity differences were present or a cumulative effect of friction occurred. This led to the concept of boundary layer, or transition layer, near the wall of a body immersed in a fluid stream in which the velocity rises from zero to the free-stream value. It is interesting that Prandtl used the term *Grenzschicht* (*boundary layer*) only once and the term *Übergangsschicht* (*transition layer*) seven times in the brief article. Later writers also used *Reibungsschicht* (*friction layer*), but most writers today use *Grenzschicht* (*boundary layer*).

Prandtl made a few qualitative experiments in a water tank 1.5 m long with a partition midway between the surface and the bottom and a paddle wheel at one end to produce flow. Photographs were taken of mica particles on the surface of the water illustrating separation around various obstacles. In one experiment he removed the boundary layer by suction through a slot, demonstrating that separation occurred only when a boundary layer was present.

The first decade produced only seven papers, all from the Göttingen group. Three graduate students made computations of the flow: Blasius (*3*) for a flat plate and Boltze (*4*) for a body of revolution in 1908, and Hiemenz (*5*) for separation on a circular cylinder in 1911. Prandtl (*6*) applied the concept to heat transfer in 1910. Töpfer (*7*), a mathematician, refined the computations of Blasius. In 1914 Prandtl (*8*) explained the critical Reynolds number of the sphere, which had been observed by Eiffel, as due to transition of the flow in the boundary layer from laminar to turbulent.

Thus, in the first 10 years, there were five workers in the boundary-layer field, all at Göttingen. Th. von Kármán, who came to Göttingen in 1906 and was graduate assistant from 1908 to 1912, gives us a delightful anecdote of those days in his most recent book, *Aerodynamics—Selected Topics in the Light of Their Historical Development* (Cornell Univ. Press, 1954). He tells how Hiemenz found oscillating flow behind the cylinder on which he was trying to measure pressure distribution and separation point for comparison with boundary-layer theory. Von Kármán thought that if the flow always oscillates, the phenomenon must have a natural and intrinsic reason. He thus became interested in the stability of the vortex street. In all this period there were no direct observations or experiments on the boundary layer itself. Every result was indirect, inferred from the gross aspects of the flow.

World War I produced a blank in the record of publications on boundary layers. G. I. Taylor, quite independently of Prandtl's boundary-layer theory, in a paper (*9*) written in 1916 but given general publication in 1920, applied the concept of the laminar sublayer in the turbulent flow in a pipe or near a plate to problems of heat transfer and skin friction. Prandtl lost his graduate students to military service. Von Kármán went to Aachen in 1912 but returned to Austria for the period of the war. Following the war, the Aachen group under von Kármán took up boundary-layer theory. The *Zeitschrift für Angewandte Mathematik und Mechanik* was founded in 1921, and its first volume contains five papers on boundary layers. Many of them were the result of work completed during the war. Von Kármán (*10*) proposed his well-known integral equation for approximate computation of the development of boundary layers along a surface, and K. Pohlhausen (*11*) applied the method to several cases, using a polynomial approximation for the velocity distribution. E. Pohlhausen (*12*) computed heat transfer. Prandtl and his group became interested in the origin of turbulence, beginning a program that was to continue intensively for many years. Noether (*13*) summarized the state of knowledge on this subject at the time. Tietjens' dissertation (*14*) on stability of laminar flow was written in 1922, and Prandtl (*15*) published a paper on the subject. In this year the precursor of the Congresses of Applied Mechanics was

held in Innsbruck. The first formal congress was held at Delft in 1924. Here Burgers (*16*) reported the first experimental observations of the velocity distribution within the boundary layer of a plate. They were made by his student, B. G. van der Hegge Zijnen (*17*). Von Kármán (*18*) gave a general lecture on the origin of turbulence. Heisenberg's paper (*19*) on stability of flow appeared. Tollmien's dissertation (*20*) was published. It dealt with the growth of the laminar boundary layer on a rotating cylinder on suddenly starting from rest.

Thus in the second decade, six years were lost as a result of the war. But now three groups, Göttingen, Aachen, and Delft, were interested. The origin of turbulence was the key theoretical problem. *Zeitschrift für angewandte Mathematik und Mechanik* was started. The first experiments had been made on the boundary layer itself. It had required 20 years to reach this point.

In 1925 Dönch's experiments (*21*) on divergent and convergent channels appeared, Tietjens' work (*22*) was published, and Bairstow (*23*) recomputed the boundary-layer flow of a flat plate. In 1926 Tollmien (*24*) tackled the problem of the turbulent wake, and Ackeret (*25*) that of control of the boundary layer by suction. The Second International Congress for Applied Mechanics was held at Zurich, and von Kármán visited the United States. In 1927 von Mises (*26*) suggested the use of the stream function as one of the independent variables in boundary-layer computations; and Prandtl (*27*) published various formulas for skin friction of a flat plate computed from data on pipes.

In 1928 Hansen (*28*) at Aachen repeated the Delft experimental measurements of velocity distribution in the laminar boundary layer of a plate. Thom (*29*) and Fage (*30*) in England computed the boundary layer over the front part of a cylinder at various Reynolds numbers. B. M. Jones (*31*) began his interest in boundary-layer problems in a classic paper on "The streamline aeroplane." Schrenk (*32*) made experiments on wings with boundary-layer suction. In 1929 Prandtl turned to the influence of stabilizing forces on turbulence (*33*) and the role of turbulence in technical hydrodynamics (*34*). Elias (*35*) made experiments on heat transfer on a plate. Levi-Civita (*36*) of Italy wrote on some consequences of the boundary-layer theory. Two British papers (*37*) showed the increasing interest in Great Britain. Tollmien's paper (*38*) on stability of laminar boundary layers appeared. Nikuradse's work (*39*) on convergent and divergent channels was published.

The year 1930 was the year of the Stockholm Congress. I am told by a friend who was at Aachen at the time that the Aachen group worked intensively in preparation for the congress, feeling a keen sense of competition with the Göttingen group and an expectancy of important results. Von Kármán's paper (*40*) on "Mechanical similarity and turbulence" appeared during the year, and a new computation (*41*) of turbulent skin friction on a plate was presented at the congress, under the same title. Prandtl had obtained essentially the same formula, but von Kármán's work was published first. In the fall of 1930 von Kármán became director of the Guggenheim Aeronautical Laboratory at the California Institute of Technology.

In 1930 there also appeared papers by Betz (*42*) and Wilcken (*43*) on the turbulent boundary layer on curved walls, Schlichting's work (*44*) on wakes, and measurement of heat transfer by Elias (*45*). Goldstein (*46*), and Falkner and Skan (*47*) in Great Britain presented the so-called "similar" solutions of the boundary-layer equations. Green (*48*) made further computations for the cylinder. The group at the National Bureau of Standards entered the field with a paper (*49*) on the effect of turbulence in wind-tunnel experiments, using the compensated hot-wire anemometer described (*50*) earlier.

In 1931 the first survey of the field was published by Tollmien in the *Handbuch der Experimental Physik*. Buri (*51*) and Gruschwitz (*52*) tackled the development of the turbulent boundary layer when it was subjected to pressure gradients. Falkner and Skan (*53*) and Fage and Falkner (*54*) presented improved methods for the laminar boundary layer under pressure gradients. Betz (*55*) commented on the von Kármán similarity hypothesis ,and Schrenk published another paper (*56*) on boundary-layer suction.

In 1932 Prandtl (*57*) further treated the turbulent boundary layer, Schlichting (*58*) wrote on the stability of the Couette flow, periodic flows in boundary layer (*59*), and the origin of turbulence in a rotating cylinder (*60*). E. Schmidt (*61*) published schlieren pictures of thermal boundary layers. G. I. Taylor (*62*) produced his vorticity and heat-transport theory. Clark Millikan (*63*) gave the theory of the boundary layer on a body of revolution. Croceo (*64*) applied boundary-layer theory to heat-transfer problems.

Schlichting's comprehensive paper (*65*) on the origin of turbulence appeared in 1933. This year also marked the demonstration by Schiller and Linke (*66*) of transition in the free vortex layer behind a cylinder at low Reynolds number. Schlichting (*67*) computed the spread of a laminar jet, and Goldstein (*68*) treated the problem of the two-dimensional wake.

In the last year of this decade, the Institute of the Aeronautical Sciences was founded, the Durand volumes on *Aerodynamic Theory* appeared, and the Fourth International Congress for Applied Mechanics was held at Cambridge, England. The first flight measurements on a boundary layer were reported by Stüper (*69*). Lyon (*70*) in England and Moore (*71*) in the United States described further work on the boundary layer on a body of revolution. Fediaevsky's (*72*) and Frankl's (*73*) papers on the turbulent boundary layer were published. Schmidbauer (*74*) computed turbulent boundary layers on curved walls. Von Kármán and Mullikan (*75*) published a theory of the laminar boundary layer with separation. I presented

to the Congress of Applied Mechanics new experimental measurements (*76*) on boundary-layer flow near a plate, including hot-wire measurements of velocity fluctuations.

In this third decade there were five or six papers per year. Interest had spread to Great Britain, the United States, and Italy. Progress had been made on the analysis of laminar and turbulent boundary layers under pressure gradients, on analysis of the boundary layer on bodies of revolution, on jets and wakes, and on the theory of stability. Additional experimental work had been accomplished on the details of boundary-layer flow on flat plates.

The fourth decade began with the Volta Congress in 1935, at which the first paper on the boundary layer in compressible flow was presented by Busemann (*77*). During this year Tollmien (*78*) described the influence on stability of an inflection in the velocity-distribution curve, and Schlichting (*79*) computed the amplitude distribution in unstable boundary-layer oscillations. Tomotika (*80*) computed the laminar boundary layer on a sphere. Howarth (*81*) improved the calculations for the cylinder. A most important paper (*82*) was Schubauer's on measurements of air flow in a separating laminar boundary layer on an elliptic cylinder. These measurements became the crucial sieve to separate good from bad approximations in laminar boundary-layer computations. An ellipse of axis ratio 2.96 to 1 has become internationally known as Schubauer's ellipse. Almost immediately the theory of von Kármán and Millikan was applied to it by Millikan (*83*) and by von Doenhoff (*84*) independently.

In 1936 the Volta Congress report became available with von Kármán's ideas on the compressible boundary layer. Homann (*85*) solved the problem of flow at a stagnation point. Goldstein and Rosenhead (*86*), Preston and Piercy (*87*), and Howarth (*88*) continued the development of methods of computation for laminar boundary layers. The National Bureau of Standards published the full report (*89*) on experimental measurements of the flat-plate boundary layer. G. I. Taylor (*90*) gave a theory of the effect of turbulence on transition in boundary layers.

In 1937 there appeared an extensive report (*91*) from the National Bureau of Standards group on the effect of intensity and scale of turbulence which confirmed Taylor's theory and by inference contradicted the stability theory of the Göttingen group. The effect of curvature on transition was reported (*92*) from experiments by the Clauser twins at the California Institute of Technology. Frankl and Voishel (*93*) attacked the compressible turbulent boundary layer. Hartree (*94*) and Sutton (*95*) continued the perennial subject of laminar boundary-layer calculations.

In 1938 the Goldstein volumes, *Modern Developments in Fluid Dynamics*, came upon the scene as the compendium of existing knowledge. The Fifth International Congress of Applied Mechanics was held at Cambridge, Massachusetts. Melvill Jones (*96*) gave the first Wright Brothers lecture on "Flight experiments on the boundary layer." Von Kármán and Tsien (*97*) treated the boundary layer in a compressible fluid.

World War II apparently did not interrupt the development, although the dissemination of information was largely restricted to the country of origin. It becomes impractical to continue to list all of the important contributions year by year. In 1939 I gave the second Wright Brothers lecture (*98*) on "Turbulence and the boundary layer," a review of the contributions of the group at the National Bureau of Standards up to that time In 1940 there were many important developments in Germany not known in other countries until much later. Hohlstein and Bohlen (*99*) developed improved methods for laminar boundary-layer calculations. Hantzsche and Wendt (*100*) made further progress with compressible laminar layers, Schlichting (*101*) with stability theory for boundary layers with pressure gradient, Görtler (*102*) with stability of flow past curved walls. Schultz-Grunow (*103*) made experiments that demonstrated the lack of equivalence of turbulent flat-plate and pipe-velocity distributions by careful experiments for the two cases. Prondtl and von Kármán has assumed the distributions to be the same. In Switzerland Ackeret, Ras, and Pfenninger's work (*104*) on boundary-layer control through suction slots was disclosed.

In 1941 Emmons and Brainerd (*105*) applied high-speed computers to the compressible laminar boundary-layer problem. Stability-theory effort continued in Germany in 1941 and 1942 with applications to boundary layers with pressure gradient (*106*) and suction (*107*).

In 1943 Schubauer and Skramstad published in a confidential report (*108*) their classic experiments which fully confirmed the stability theories of the Göttingen school when the turbulence of the wind-tunnel air stream is low. This report was not made available in unclassified form until 1946. Mangler (*109*) discussed the "similar" solutions; Liepmann (*110*) described experiments on transition on curved walls.

In 1944 Iglisch (*111*) and Ulrich (*112*) computed the laminar boundary layer on a plate with suction. Schaefer (*113*) described solutions for a plate with suction with power law and exponential free-stream velocity variation with distance. Wieghardt (*114*) checked experimentally that increasing turbulence for flow near a plate would change the velocity profile of plate to that of pipe flow.

In the fourth decade there were about 14 papers per year. The laminar boundary-layer development and its stability were fairly well understood with correlated theoretical and experimental results. The turbulent boundary layer was not understood, but empirical procedures were available. Some empirical information on transition had been obtained. Numerous investigations had been made of the influence of compressibility. Boundary-layer suction for drag reduc-

tion was under active study. Only two-dimensional boundary layers and boundary layers on bodies of revolution had been treated.

The work that has been discussed so far is primarily that thought worthy of mention in Durand's *Aerodynamic Theory,* Goldstein's *Modern Developments in Fluid Mechanics,* and the recent book *Grenzschichttheorie* by Schlichting, published in 1951. To obtain a picture of the more recent effort, the critical reviews in *Applied Mechanics Reviews* were inspected. An attempt was made to select the work that dealt with theory and with experiments aimed at understanding the boundary layer itself, but admittedly the selection of titles is somewhat arbitrary. To these were added more recent papers in the current journals. The total was 561 papers, beginning with 43 in 1948, and 40, 68, 87, 95, 100, and 128 (part of 1954) in the succeeding years. This leaves a gap of a few years between the end of the first 40 years and the establishment of *Applied Mechanics Reviews* which has been covered by reference to Schlichting's book and other sources. The remaining discussion is by subject headings that are not mutually exclusive but are suggestive of the major fields of activity.

Strange as it may seem, the story of the laminar incompressible boundary layer is not exhausted with about 70 papers in this area reviewed in 6 years. Schlichting adopted Howarth's 1938 computation of the Blasius distribution for the flat plate without pressure gradient so that this bit may be regarded as closed. However, Mangler (*115*) proposed a two-parameter method for approximate calculations for the pressure-gradient case, and Wieghardt (*116*) carried through the procedure using both momentum and energy theorems and a polynomial of the 11th degree for the velocity distribution. Walz (*117*) proposed to return to a one-parameter family by abandonment of one of the boundary conditions that had always been regarded as essential. There has been little new experimental work, but the fine interferograms of Ladenberg and Bershader (*118*) should perhaps be mentioned.

The laminar compressible case continues to be of great interest. Again the papers deal mainly with approximate theories. Variable fluid properties have been introduced into the computations and further application made of high-speed computing machines. About 60 papers have been reviewed in *Applied Mechanics Reviews,* but of these only five present experimental data.

The turbulent incompressible boundary layer receives considerable attention with about 45 papers. Experimental investigations of the National Bureau of Standards group under Schubauer (*119, 120*), of Townsend (*121*) at Cambridge, England, and of Ludwieg and Tillmann (*122*) in Germany have contributed much to our understanding of the structure and statistical aspects of turbulent boundary layers. There have been some refinements in empirical methods of calculating their development under pressure gradients.

About 35 papers on the turbulent compressible boundary layer were reviewed. Mention may be made of the similarity theories of Lin and Shen (*123*) and of the study of integral methods by Libby, Morduchow, and Bloom (*124*). The theoretical and experimental work by Chapman, Rubesin, and their coworkers (*125*) has added much to our knowledge of this field.

The phenomena of separation in both laminar and turbulent and in both compressible and incompressible boundary layers, with and without heat transfer, although not in all combinations, account for some 30 papers. The experiments of Ackeret, Feldmann, and Rott (*126*) and of Liepmann (*127*) are now well known, as are the experiments of Schubauer and Klebanoff (*119*) on the separation of the turbulent incompressible layer. An interesting experimental study is that of Bursnall and Loftin (*128*) on localized regions of laminar separation, which has been continued by Gault (*129*).

Hypersonic boundary layers account for some 15 papers, and this is a field of growing interest.

Stability and transition form the principal topic of about 70 papers, with special attention in recent years to the compressible boundary layer and the effects of heating and cooling. The effects of roughness and wall waviness on transition are of renewed interest.

Hammerlin, a student of Görtler, has recomputed (*130*) the stability limits for concave walls and confirmed Görtler's old result as correct, although a new computation by Meksyn (*131*) had given somewhat different results. New experiments have been made on the nature of transition by Emmons (*132*) and by Evvard (*133*) and his colleagues. Dunn and Lin (*134*) have reopened the question of the stabilizing effect of cooling by showing that compressible boundary layers may be more sensitive to three-dimensional disturbances than to the two-dimensional disturbances for which the calculations have been made.

About 70 papers deal with the more specific applications of the boundary-layer concept to the heat-transfer problem. The work of Tifford and his coworkers (*135*) on laminar heat transfer deserves special mention, as does that of R. A. Seban, S. Levy, and their colleagues (*136*)

Control of the boundary layer by suction is still a very active subject, with some 40 reviews. Area suction and suction through slots for control of separation and for drag reduction are represented.

There are many papers that do not fit the categories selected for discussion, about 35 in number. I shall mention only the beautiful experiments of Dhawan (*137*) on the direct measurement of skin friction and the studies of the general mathematical character of solutions of the Navier-Stokes equations, with special reference to boundary layers and shock waves, that have been carried out by Lagerstrom and his colleagues (*138*) at California Institute of Technology.

Most of the work referred to previously dealt with boundary layers in two-dimensional flow. There are about 10 reviews on axisymmetric boundary layers.

The more difficult study of flow in three-dimensional boundary layers was begun by Prandtl (*139*) in 1945. I shall not discuss this subject, represented by about 40 papers, since W. R. Sears has recently reviewed this field in an article (*140*) in *Applied Mechanics Reviews*, except to mention the important Mangler transformation published in 1948 (*141*). This makes possible the determination of a two-dimensional boundary-layer flow that is equivalent to a given axially symmetric boundary-layer flow. It is valid both for compressible and incompressible boundary layers.

There are some 10 reviews dealing with boundary layers on spinning bodies. There are also a few papers on boundary layers with a gas or liquid injected into the layer through a porous surface. There are about 15 papers on boundary layers in oscillating or other nonstationary flow.

If one examines the statistical picture of the whole 50 years, there are of the order of 800 papers written by 500 authors. Half of the papers were written by less than 100 of the authors. About one-third of these highly productive authors are experimentalists, the other two-thirds deal with theory. The theoretical workers write about 1.5 times as many papers per worker as the experimentalists. The current total rate of production of papers is about 10 papers per month, nearly 9 times the rate immediately preceding World War II. Such rough statistics are interesting but may be misleading. Papers such as those on the Tollmien-Schlichting theory of the stability of the laminar boundary layer and on the Schubauer-Skramstad experimental confirmation are very rare indeed.

The growth of interest in the new concept of Prandtl during the first 30 years was very slow, partly because of slow communication to groups in other countries and partly because there was no direct experimental evidence of its correctness. Measurements of flow within the boundary layer had to await the development of hot-wire anemometers and very small pressure probes. There was, however, a more important factor in the initial slow growth. Early papers were mainly doctoral dissertations, and many of the authors turned to other fields after receiving their degrees. There was no engineering or technologic activity in industry to employ them to apply or to extend their knowledge of boundary-layer flow. Only when the aeronautical industry reached a relatively advanced state of engineering development were practical applications found. Then the boundary-layer concept was fruitful, not only for computation of skin friction and flow separation, but also for unifying and clarifying experimental data from wind-tunnel and flight experiments. The expansion of aeronautics stimulated basic research; it also provided a demand for engineers and scientists familiar with theoretical and experimental aspects of flow in boundary layers.

Along with successful application in aeronautical engineering, the boundary-layer concept diffused into other engineering fields—mechanical engineering, hydraulic engineering, and chemical engineering. Similarly, studies of heat transfer, diffusion, and evaporation in moving fluids were greatly aided by knowledge of boundary-layer flow. These developments interacted to produce an almost exponential growth of interest in research on boundary-layer flow within the past decade. The progress of the new concept has been very great, and the intense activity of the present leads us to hope for further advances in understanding and application in the near future.

References and Notes

1. Based on an address given at a dinner meeting of the Fluid Dynamics Division, American Physical Society, Hotel Chamberlin, Old Point Comfort, Va., 23 Nov. 1954.
2. L. Prandtl, *Verhandl. III Intern. Math. Kongr.; repr. Vier Abhandl. zur Hydro- und Aerodynamik*, Göttingen (1927).
3. H. Blasius, *Z. Math. u. Physik.* **56**, 1 (1908); Eng. trans. in *Natl. Advisory Comm. Aeronaut. Tech. Mem.* No. 1256.
4. E. Boltze, dissertation, Göttingen (1908).
5. K. Hiemenz, *Dinglers Polytech. J.* **326**, 32 (1911).
6. L. Prandtl, *Physik. Z.* **11**, 1072 (1910).
7. C. Töpfer, *Z. Math. u. Physik.* **60**, 397 (1912).
8. L. Prandtl, *Göttingen Nach.* (1914), p. 177.
9. G. I. Taylor, *Brit. Aeronaut. Research Comm. Repts. and Mem.* No. 272 (1916).
10. Th. von Kármán, *Z. angew. Math. u. Mech.* **1**, 233 (1921).
11. K. Pohlhausen, *ibid.* **1**, 252 (1921).
12. E. Pohlhausen, *ibid.* **1**, 115 (1921).
13. F. Noether, *ibid.* **1**, 125 (1921).
14. O. Tietjens, dissertation, Göttingen (1922).
15. L. Prandtl, *Z. angew. Math. u. Mech.* **1**, 431 (1921); *Physik. Z.* **23**, 19 (1922).
16. J. M. Burgers, *Proc. First Intern. Congr. Appl. Mech.*, p. 113.
17. B. G. van der Hegge-Zijnen, thesis, Delft (1924).
18. Th. von Kármán, *Proc. First Intern. Congr. Appl. Mech.*, p. 97.
19. W. Heisenberg, *Ann. Physik.* **24**, 577 (1924).
20. W. Tollmien, dissertation, Göttingen (1924).
21. F. Dönch, dissertation, Göttingen (1925).
22. O. Tietjens, *Z. angew. Math. u. Mech.* **5**, 200 (1925).
23. L. Bairstow, *J. Roy. Aeronaut. Soc.* **19**, 3 (1925).
24. W. Tollmien, *Z. angew. Math. u. Mech.* **6**, 468 (1926).
25. J. Ackeret, *Z. Ver. deut. Ing.* **35**, 1153 (1926).
26. R. von Mises, *Z. angew. Math. u. Mech.* **7**, 425 (1927).
27. L. Prandtl, *Ergeb. Aerodyn. Versuchs. Göttingen*, III (1927).
28. M. Hansen, *Z. angew. Math. u. Mech.* **8**, 185 (1928).
29. A. Thom, *Brit. Aeronaut. Res. Comm. Repts. and Mem.* No. 1176 (1928).
30. A. Fage, *Phil. Mag.* **7**, 253 (1929).
31. B. M. Jones, *J. Roy. Aeronaut. Soc.* **33**, 357 (1929).
32. O. Schrenk, *Luftfahrt-Forsch.* **2**, 49 (1928).
33. L. Prandtl, *Vorträge aus dem Gebiete der Aerodynamik und verwandte Gebiete, Aachen 1929* (Springer, Berlin, 1930), p. 1.
34. ———, *Proc. World Eng. Congr. Tokyo, 1929* **5** (1931).
35. F. Elias, *Z. angew. Math. u. Mech.* **9**, 434 (1929).
36. T. Levi-Civita, *Vorträge aus dem Gebiete der Aerodynamik und verwandte Gebiete, Aachen 1929* (Springer, Berlin, 1930).
37. L. F. G. Simmons, *Brit. Aeronaut. Res. Comm. Repts. and Mem.* No. 1268 (1929); E. Ower and C. T. Hutton, *ibid.* No. 1271 (1929).
38. W. Tollmien, *Nach. Ges. Wissen. Göttingen, Math-physik. Kl. 21* (1929); Eng. trans. in *Natl. Advisory Comm. Aeronaut. Tech. Mem.* No. 609 (1931).
39. J. Nikuradse, *Forschungs. Ver. deut. Ing.*, 289 (1929).
40. Th. von Kármán, *Nach. Ges. Wissen. Göttingen, Math.-physik. Kl. 58* (1930).
41. ———, *Verhandl. III Intern. Kongr. Techn. Mechanik*, Teil I, 85.
42. A. Betz, *Vorträge aus dem Gebiete der Aerodynamik und verwandte Gebiete, Aachen 1929* (Springer, Berlin, 1930), p. 10.
43. H. Wilcken, *Ing. Arch.* **1**, 357 (1930).
44. H. Schlichting, dissertation, Göttingen (1930); *Ing. Arch.* **1**, 537 (1930).
45. F. Elias, *Z. angew. Math. u. Mech.* **10**, 1 (1930).
46. S. Goldstein, *Proc. Cambridge Phil. Soc.* **26**, pt. I (1930).

47. V. M. Falkner and S. W. Skan, *Brit. Aeronaut. Res. Comm. Repts. and Mem.* No. 1314 (1930).
48. J. J. Green, *ibid.* No. 1313 (1930).
49. H. L. Dryden and A. M. Kuethe, *Natl. Advisory Comm. Aeronaut. Rept.* No. 342 (1929).
50. ———, *ibid.* No. 320 (1929).
51. A. Buri, dissertation, Zurich (1931).
52. E. Gruschwitz, *Ing. Arch.* **2**, 321 (1931).
53. V. M. Falkner and S. W. Skan, *Phil. Mag.* **12**, 865 (1931).
54. A. Fage and V. M. Falkner, *Brit. Aeronaut. Res. Comm. Repts. and Mem.* No. 1369 (1931).
55. A. Betz, *Z. angew. Math. u. Mech.* **11**, 397 (1931).
56. O. Schrenk, *Z. Flugtech. Motorluftsch.* **22**, 259 (1931).
57. L. Prandtl, *Ergeb. Aerodyn. Versuchs. Göttingen*, IV (1932).
58. H. Schlichting, *Ann. Physik* V, 905 (1932).
59. ———, *Physik. Z.* **33**, 327 (1932).
60. ———, *Nach. Ges. Wissen. Göttingen, Math.-phys. Kl.* *160* (1932).
61. E. Schmidt, *Forsch. Ing. Wes.* **3**, 181 (1932).
62. G. I. Taylor, *Proc. Roy. Soc. London* **135**, 685 (1932).
63. C. B. Millikan, *Trans. Am. Soc. Mech. Engrs.* **54**, 29 (1932).
64. L. Crocco, *Rend. accad. Lincei*, **14**, 490 (1931) ; *Aerotecnica* **12**, 181 (1932).
65. H. Schlichting, *Nach. Ges. Wissen. Göttingen, Math.-phys. Kl.* *182* (1933).
66. L. Schiller and W. Linke, *Z. Flugtech. Motorluftsch.* **24**, 193 (1933).
67. H. Schlichting, *Z. angew. Math. u. Mech.* **13**, 260 (1933).
68. S. Goldstein, *Proc. Roy. Soc. London* **142**, 545 (1933).
69. J. Stüper, *Luftfahrt-Forsch.* **XI**, 26 (1934).
70. H. M. Lyon, *Brit. Aeronaut. Res. Comm. Repts. and Mem.* No. 1622 (1934).
71. N. B. Moore, thesis, California Inst. of Technology (1934).
72. K. Fedïaevsky, *Trans. Central Aero. Hydro. Inst.*, No. 179 (1934).
73. F. Frankl, *ibid.*, No. 176 (1934).
74. H. Schmidbauer, dissertation, Munich (1934) ; Luftfahrt-Forsch. **XIII**, 161 (1936).
75. Th. von Kármán and C. B. Millikan, *Natl. Advisory Comm. Aeronaut. Rept.* No. 504 (1934).
76. H. L. Dryden, *Proc. Fourth Intern. Congr. Appl. Mech.* (1934), p. 175.
77. A. Busemann, *Z. angew. Math. u. Mech.* **15**, 23 (1935).
78. W. Tollmien, *Nach. Ges. Wissen. Göttingen, Math.-phys. Kl.* **1**, 79 (1935).
79. H. Schlichting, *ibid.*, 47 (1935).
80. S. Tomotika, *Brit. Aeronaut. Res. Comm. Repts. and Mem.* No. 1678 (1935).
81. L. Howarth, *ibid.*, No. 1632 (1935).
82. G. B. Schubauer, *Natl. Advisory Comm. Aeronaut. Rept.* No. 527 (1935).
83. C. B. Millikan, *J. Aeronaut. Sci.* **3**, 91 (1936).
84. A. E. von Doenhoff, *Natl. Advisory Comm. Aeronaut. Tech. Note* No. 544 (1935).
85. F. Homann, *Z. angew. Math. u. Mech.* **16**, 153 (1936).
86. S. Goldstein and L. Rosenhead, *Proc. Cambridge Phil. Soc.* **32**, 392 (1936).
87. G. H. Preston and N. A. V. Piercy, *Phil. Mag.* **21**, 995 (1936).
88. L. Howarth, *Proc. Roy. Soc. London* **154**, 364 (1936).
89. H. L. Dryden, *Natl. Advisory Comm. Aeronaut. Rept.* No. 562 (1936).
90. G. I. Taylor, *Proc. Roy. Soc. London* **156**, 307 (1936).
91. H. L. Dryden *et al.*, *Natl. Advisory Comm. Aeronaut. Rept.* No. 581 (1937).
92. M. Clauser and F. Clauser, *Natl. Advisory Comm. Aeronaut. Tech. Note* No. 613 (1937).
93. F. Frankl and V. Voishel, *Trans. Central Aero. Hydro. Inst.*, No. 321 (1937).
94. D. R. Hartree, *Proc. Cambrdige Phil. Soc.* **33**,, Pt. II, 223 (1937).
95. W. G. L. Sutton, *Phil. Mag.* **23**, 1146 (1937).
96. B. M. Jones, *J. Aeronaut. Sci.* **5**, 81 (1938).
97. Th. von Kármán and H. S. Tsien, *ibid.* **5**, 227 (1938).
98. H. L. Dryden, *ibid.* **6**, 85 (1939).
99. H. Holstein and T. Bohlen, *Lilienthal-Ber.*, S10, 5 (1940).
100. W. Hantzsche and H. Wendt, *Jahrb. deut. Luftfahrt-Forsch.* **I**, 517 (1940).
101. H. Schlichting, *ibid.* **I**, 97 (1940).
102. H. Görtler, *Z. angew. Math. u. Mech.* **20**, 138 (1940).
103. F. Schultz-Grunow, *Luftfahrt-Forsch.* **17**, 239 (1940). Eng. trans. in *Natl. Advisory Comm. Aeronaut. Tech. Mem.* No. 986 (1941).
104. J. Ackeret, M. Ras, and W. Pfenninger, *Naturwissenschaften* **41**, 622 (1941) ; *Helv. Phys. Acta* **14**, 323 (1941) ; *Mitt. Inst. Aerodyn.*, ETH Zurich, No. 13 (1946) ; *J. Aeronaut. Sci.* **16**, 227 (1949).
105. H. W. Emmons and J. G. Brainerd, *J. Appl. Mechanics* **8**, 105 (1941) ; *ibid.* **9**, 1 (1942).
106. J. Pretsch, *Jahrbuch deut. Luftfahrt-Forsch.* **I**, 58 (1941) ; *ibid.* **I**, 54 (1942).
107. K. Bussmann and H. Munz, *ibid.* **I**, 36 (1942).
108. G. B. Schubauer and H. K. Skramstad, *Natl. Advisory Comm. Aeronaut. wartime Rept.* W8 ; *J. Research Nat. Bur. Standards* **38**, 251 (1947) ; *J. Aeronaut. Sci.* **14**, 69 (1947) ; *Natl. Advisory Comm. Aeronaut. Rept.* No. 909 (1948).
109. W. Mangler, *Z. angew. Math. u. Mech.* **23**, 243 (1943).
110. H. Liepmann, *Natl. Advisory Comm. Aeronaut.*, ACR 3H30 (1943).
111. R. Iglisch, *Schriften deut. Akad. Luftfahrt-Forsch.*, 8B, vol. 1 (1944). Eng. trans. in *Natl. Advisory Comm. Aeronaut. Tech. Mem.* No. 1205 (1949).
112. A. Ulrich, *Schriften deut. Akad. Luftfahrt-Forsch.*, 8B, vol. 2 (1944).
113. H. Schaefer, *Deut. Luftfahrt-Forsch.*, UM 2043 (1944).
114. K. Wieghardt, *Z. angew. Math. u. Mech.* **24**, 294 (1944).
115. W. Mangler, *ibid.* **24**, 251 (1944).
116. K. Wieghardt, *Ing. Arch.* **16**, 231 (1948).
117. A. Walz, *ibid.* **16**, 248 (1948).
118. R. Ladenberg and D. Bershader, *Revs. Mod. Phys.* **21**, 510 (1949).
119. G. B. Schubauer and P. S. Klebanoff, *Natl. Advisory Comm. Aeronaut. Tech. Note.* No. 2133 (1950).
120. G. B. Schubauer, *J. Appl. Phys.* **25**, 188 (1954).
121. A. A. Townsend, *Proc. Cambridge Phil. Soc.* **47**, pt. 2, 375 (1951).
122. H. Ludwieg and W. Tillmann, *Ing. Arch.* **17**, 288 (1949) ; *Z. angew. Math. u. Mech.* **29**, 15 (1949).
123. C. C. Lin and S. F. Shen, *Natl. Advisory Comm. Aeronaut. Tech. Note* No. 2542 (1951).
124. P. A. Libby, M. Morduchow, and M. Bloom, *ibid.*, No. 2655 (1952).
125. D. R. Chapman and M. W. Rubesin, *J. Aeronaut. Sci.* **16**, 547 (1949) ; ——— and R. H. Kester, *Natl. Advisory Comm. Aeronaut. Tech. Note* No. 3097 (1954).
126. J. Ackeret, F. Feldmann, and N. Rott, *Mitt. Inst. Aerodyn.*, ETH Zurich, Rept. No. 10 (1946).
127. H. Liepmann, *J. Aeronaut. Sci.* **13**, 623 (1946).
128. W. J. Bursnall and L. K. Loftin, *Natl. Advisory Comm. Aeronaut. Tech. Note* No. 2338 (1951).
129. D. B. Gault, *ibid.*, in press.
130. G. Hammerlin, unpublished.
131. D. Meksyn, *Proc. Roy. Soc. London* **203**, 253 (1950).
132. H. W. Emmons, *J. Aeronaut. Sci.* **18**, 490 (1951).
133. J. C. Evvard, M. Tucker, and W. C. Burgess, Jr., *Natl. Advisory Comm. Aeronaut. Tech. Note* No. 3100 (1954) ; *J. Aeronaut. Sci.* **21**, 731 (1954).
134. D. W. Dunn and C. C. Lin, *J. Aeronaut. Sci.* **20**, 577 (1953).
135. A. N. Tifford and S. T. Chu, *Proc. Second Midwestern Conf. on Fluid Dynamics*, 363 (1952) ; *J. Aeronaut. Sci.* **17**, 187 (1950) ; *ibid.* **18**, 283, 358, 427 (1951) ; *ibid.* **20**, 643 (1953).
136. S. Levy and R. A. Seban, *J. Appl. Mech.* **20**, 415 (1953) ; *J. Aeronaut. Sci.* **18**, 671 (1951) ; *Trans. Am. Soc. Mech. Engrs.* **76**, 519 (1954).
137. S. Dhawan, *Natl. Advisory Comm. Aeronaut. Tech. Note* No. 2567 (1952) ; *Natl. Advisory Comm. Aeronaut. Rept.* No. 1121 (1953).
138. P. A. Lagerstrom, J. D. Cole, and L. Trilling, *Problems in the Theory of Viscous Compressible Fluids* (Calif. Inst. of Technology, Pasadena, 1949).
139. L. Prandtl, *Albert Betz Festschrift* (Göttingen, 1945), p. 59 ; N. Tetervin, *Natl. Advisory Comm. Aeronaut. Tech. Note* No. 1479 (1947).
140. W. R. Sears, *Appl. Mech. Revs.* **7**, 281 (1954).
141. W. Mangler, *Z. angew. Math. u. Mech.* **28**, 97 (1948).

News and Notes

Southwestern and Rocky Mountain Division 1955 Meeting

The Southwestern and Rocky Mountain Division of the AAAS will hold at least part of its annual meeting, 24 Apr.–4 May, in historic Santa Fe, N.M. Included in the events scheduled for the period are visits, planned by the local committee on arrangements, to various museums such as the Laboratory of Anthropology, the Hall of Ethnology, the Museum of International Folk Art, and the Palace of the Governors as well as trips to the Indian ruins and modern villages and the interesting and unique Santa Fe shops.

Sessions of the various sections devoted to the presentation of scientific papers will be held 24–26 Apr. Registration, starting 24 Apr., will continue throughout the meeting. A dinner will be held Sunday evening followed by addresses of welcome, and on Monday evening the annual dinner will be climaxed by the Powell lecture to be given this year by Paul B. Sears of Yale University, president-elect of the AAAS. The business meeting for the election of officers will be held Tuesday afternoon at an hour early enough to permit arrival in Albuquerque in time for dinner by those who plan to attend the International Arid Meetings, which the Division is cosponsoring with the AAAS.

The International Arid Lands Meetings, 26–29 Apr., are a culmination of the activities of the Division's committee on arid lands which succeeded, with the aid of the national officers, in obtaining financial aid from the National Science Foundation, the Rockefeller Foundation, and UNESCO. (See *Science*, 11 Feb. 1955, or *The Scientific Monthly*, March 1955, for details. See ad in this issue for registration and housing.)

Because Santa Fe is well provided with hotel and motel facilities, guests are asked to make their own housing arrangements, either directly or through local chambers of commerce. Advance registration for dinners should be made with E. Boyd at the Museum of New Mexico in Santa Fe by 15 Apr.

It has been 20 years since the Division met in Santa Fe, but the choice of this city is a felicitous one for such an organization. It is situated on the southwest slope of the Sangre de Christo range which, with the Jemez range to the west, comprises the most southerly extension of the Rocky Mountain system. The Santa Fe River flows through the city and joins the Rio Grande some 20 mi to the southwest. The Jemez Plateau with its spectacularly eroded volcanic and sedimentary deposits extends from the Jemez range to the Rio Grande varying from 10 to 20 mi in width with a north-south extension of 40 mi. El Valle Grande, a huge volcanic basin, or caldera, is enclosed by numerous prominent Jemez peaks, between which the floor of the Rio Grande Valley lies some 5500 ft above sea level.

Historically, Santa Fe extends in time back to 1609–10 and prehistorically to a background as yet incompletely studied. Vestiges of both historic and prehistoric cultures abound to furnish the visitor with a wealth of scientific data. Among other particularly interesting Santa Fe landmarks are the prehistoric and the living pueblos.

The area's vegetation zones range from *Sonoran* with cottonwoods and willows, juniper and pinon, sages, yuccas, and cacti through the *Transition* zone (western yellow or ponderosa pines, lanceheaded cottonwood, and so forth), and the *Canadian* (Douglas tree, western white pine, fir, spruce, and aspen) to the *Hudsonian* (Englemann spruce, dwarf willow, and Siberian juniper), and into the *Arctic-Alpine* zone (which is treeless with low matted vegetation). Zoologist and geologist, too, will find a wealth of material, ranging from living creatures to interesting fossil deposits.

For all the registrants, there is the added interest of the nearness of Los Alamos, only an hour's drive to the west, and the fact that all this Santa Fe area has recently become of nationwide interest because of uranium prospecting there.

F. E. E. GERMANN

University of Colorado, Boulder

Science News

Chromosome numbers have been recorded for only a very few species of Primates. Of the catarrhine or Old World pithecoid primates, only three species, namely, man (*Homo sapiens*), a chimpanzee (*Pan calvus*), and the rhesus monkey (*Macaca mulatta*), have been reported on; and 48 chromosomes have been claimed for all three of these animals. C. D. Darlington and A. Haque [*Nature* **175**, 32 (1 Jan. 1955)], using newer techniques, have confirmed the **chromosome number** 48 for man, but have found only 42 chromosomes in each of three species of Old World monkeys: the Guinea baboon (*Papio papio*), the pigtailed macaque (*Macaca nemestrinus*), and the rhesus monkey (*M. mulatta*). They found that the chromosomes of man and monkeys are generally not unlike. The three species of monkeys, however, are alike in two respects in which they differ from man: (i) They lack the pair with median centromeres which is the largest pair in man, and (ii) they have a Y chromosome that is much smaller than the human Y.—W.L.S., JR.

The loyalty case of **John P. Peters**, professor of medicine at Yale University [*Science* **119**, 500 (16 Apr. 1954); **120**, 415 (10 Sept. 1954)] is soon to be reviewed by the U.S. Supreme Court. On 3 Mar. the Justice Department submitted a brief to the Court urging that it uphold Peters' dismissal as a consultant for the National Institutes of Health because there was "reasonable doubt" of his loyalty. The brief,

signed by Herbert Brownell, Jr., U.S. Attorney General, said that Government employees are not entitled to judicial review of their dismissals and that the security of the country might be endangered if employees charged with disloyalty are permitted to confront their accusers.

An earlier brief filed last January on behalf of Peters, who has denied under oath that he was a Communist, urged the court to find the Government loyalty program unconstitutional. Peters contends that the constitutional guarantee of due process of law requires that he be informed of the nature of the derogatory matter being used against him and of the identity of those who placed it in the record. He states that he was not given an opportunity to defend himself against "unsworn, second-hand statements to the F.B.I." provided by unnamed informants.

The Justice Department brief emphasizes that the Government's security operations depend heavily on "undercover agents, paid informers and casual informers" whose anonymity must be guaranteed. In contrast, President Eisenhower said in a speech in 1953 that the right to meet one's accuser "face to face" was a basic American privilege that could not be taken away.

The Atomic Energy Commission and the American Society of Mechanical Engineers will share the cost of a $25,000 engineering project to develop information about **high-temperature piping.** The investigations will be performed by the AEC's Knolls Atomic Power Laboratory, Schenectady, New York, which is operated by the General Electric Co. The ASME, on behalf of American industry, will contribute $10,000, and a group of ASME technical experts will be available at no cost to the Government for consultations in the programing and evaluation of the work.

The project will continue studies of thermal fatigue in ductile metals that were originally undertaken by the AEC to aid in the construction of reactors. General engineering information applicable to heat-transfer systems will be developed that will be of future benefit to the AEC program. Private industry has an immediate need for data in this area, and the society has undertaken to sponsor the work for this reason. The testing facilities to be used and the results obtained will be unclassified. The work, which is to be performed under contract between the ASME and the General Electric Co., will be directed by L. F. Coffin, Jr.

Under the sponsorship of the U.S. Department of Agriculture, there was organized a year ago a **National Conference on FAO** (Food and Agriculture Organization of the United Nations). The main objective of the conference is to arrange a meeting of its members and the appropriate U.S. officials (departments of Agriculture and State) to inform members of the conference of the problems, policies, and programs that are currently being considered by FAO. The views and suggestions of the members of the conference on these questions are invited.

The conference is made up of representatives of nongovernmental organizations interested in FAO, such as national farm organizations, agricultural marketing groups, private agencies concerned with foreign aid programs, and scientific societies whose members are taking part in technical-assistance programs related to agriculture.

When the AAAS was invited to send a representative to the conference, the board of directors appointed Noble Clark, associate director of the Agricultural Experiment Station, University of Wisconsin. He advises that current policy issues include such questions as the following.

1) What portion of the U.S. funds for technical agricultural assistance should be administered directly by the United States, and what by the international organization, FAO?

2) Should the assistance to other nations from the United States directly, or through FAO, continue along the same general lines as at present, or should more emphasis be placed on technical aid and research in building up the local educational agencies, in contrast to giving funds for economic assistance?

3) Should the United States welcome larger participation and over-all supervision of technical-aid programs and budgets by the officials of the United Nations in New York, or would it be preferable to have our Government make essentially all of its technical-aid grants directly to the specialized agencies such as FAO, UNESCO, and WHO?

Clark will welcome suggestions and comments, particularly from those who have had firsthand experience in serving as technical advisers in other nations.

The American Institute for Biological Sciences and the American Psychological Association are among the six organizations recently admitted to the **U.S. National Commission for UNESCO.** Sixty national organizations are represented on the commission.

In connection with the Inter-American Medical Convention, held in Panama, Republic of Panama, during observance of the 50th anniversary of the beginning of the Panama Canal, Charles M. Gratz, Greenwich, Conn., delivered an address dealing with **orthopedic and traumatic surgery.** Associate professor of clinical surgery at New York Medical College and Flower Fifth Avenue Hospital and associate attending orthopedic surgeon at New York University and New York City Hospitals, Gratz was also a member of the Pan American Flying Clinic which, in 1930, introduced certain new orthopedic and traumatic advances in 11 inter-American countries.

In his address Gratz paid tribute to the work in Panama of General Gorgas and his medical associates, which "not only made the building of the Panama possible but established a foundation on which preventive medicine has been built."

Since 1930 when medical pioneers, including Gratz himself, began "preventive surgery" to parallel the work in preventive medicine, the blending of pioneer traumatic limb-saving techniques with modern ortho-

pedic and rehabilitation surgery has resulted in sustained progress along with the successful transplantation of biochemical and living suture techniques from the United States and Canada. The study of human locomotion and the biomechanics of surgery is not of interest only to the surgeon, Gratz pointed out, but to the engineer and the biologist as well. During World War II, all three groups joined to make biomechanics a key to the saving of lives of combat aerial personnel, but the biomechanical program was planned for civilian safety as well as the safety of military personnel. Some of the results were rearward seating in aircraft and vehicular crash research.

Gratz also reviewed the development of fascial and capsular surgery, studies of the functional mechanics of the soft tissues, and modern methods of treating fractures. He stated that he believed that bone grafting with living suture fixation will be used in the surgery of the future instead of metal splice plates, rivets, and bone plates, particularly because hardware is not only subject to corrosion and electrolytic action, but also to engineering stresses, and because of the problem of treating patients in which infection has occurred around hardware.

Gratz concluded his address, which was reprinted in the *Connecticut State Medical Journal* [**18**, 12 (1954)] by stating that the role of biomechanics, human kinetics, and biological enigneering is best visualized in the words of Arthur Steindler:

> . . . We see at long last with great satisfaction that kinetics of the human body has come into its own. It is to be expected that this will be a major issue in the future when the kinetics of the human body becomes fully accepted in clinical practice; when it is given equal rank with anatomy and pathology; and when it is finally realized that without this ancillary science no orthopedic training can be called adequate.

An engineering evaluation of a nuclear power plant system using liquid metal as fuel is under way at the Atomic Energy Commission's Brookhaven National Laboratory in Upton, N.Y. The evaluation or feasibility study is being conducted by Babcock and Wilcox Co., New York, for a group of 17 organizations, 14 of them industrial.

Preliminary designs for the system, known as **Liquid Metal Fuel Reactor,** were developed by Brookhaven. The system is intended to generate electric power, "breed" new fuel for itself, and deliver by-products to waste tanks—all in continuous processes. It would provide the first usage of a liquid metal alloy, in this case uranium-bismuth, as the fuel stream to interconnect continuous processes.

Seventeen scientists and engineers, working full time, and several more part-time consultants are engaged in the work; a preliminary report will be submitted 1 Apr. and a final one 30 June. Under a lump-sum contract, Babcock and Wilcox will receive $72,500 for supplying over-all administration, supervision of the comprehensive analysis of Brookhaven data, and preparation of the detailed report. Glen J. Schoessow of Babcock and Wilcox is heading the study group, and Robert T. Schomer is in charge at Upton. Clarke Williams is chairman of the Brookhaven nuclear engineering department, which developed the LMFR scheme.

On 16 Feb. the **American Society of Mechanical Engineers** celebrated its 75th anniversary with a ceremony that took place in the auditorium of the McGraw-Hill Publishing Co. in New York. Some 30 people participated in the founding meeting on the same date in 1880; the society now has a membership of 40,000 engineers in North America.

Scientists in the News

Three anthropologists, **W. Duncan Strong** of Columbia University, **W. W. Howells** of Harvard University, and **Robert Redfield** of the University of Chicago received Viking Fund medals during the 9th annual dinner of the Wenner-Gren Foundation for Anthropological Research, Inc., in New York on 4 Mar.

Strong was selected as medalist in archaeology by the Society for American Archaeology "for the stimulation he has given projects . . . , for the breadth of his attainments, and for the outstanding students he has developed."

Howells was chosen by the American Association of Physical Anthropologists to receive the medal in physical anthropology in recognition of his studies on physical differentiation and his editorial contributions.

Redfield, medalist in general anthropology, was selected by the American Anthropological Association.

Louis G. Dunn, associate director of the guided missile division of the Ramo-Wooldridge Corp., Los Angeles, has received the certificate of appreciation from the Department of the Army. This certificate, the Army's highest civilian award and one of three awarded within the past 10 yr, was presented to Dunn for his work from 1947 to 1954 as director of the Jet Propulsion Laboratory operated for the Army by California Institute of Technology. The citation read:

> . . . Characteristic of these accomplishments were the development of many rocket propellants now in use, and research leading to improved propellants that will be widely used in future weapons, research and testing supersonic wind tunnels affecting in a major degree almost all planned and existing guided missile programs, and the conversion of a research test missile into the Corporal guided missile system, which provided the using arms with the first rocket-powered surface-to-surface guided missile in the national program.

William E. Adams and his wife, **Huberta M. Livingstone,** both scientists, have just returned from a lecture tour in Mexico. Adams, who is the James Nelson and Anna Louise Raymond professor of surgery at the University of Chicago, was made honorary professor of surgery at the University of Guadalajara, and both were made honorary members of the Guadalajara Surgical Society.

Clifton K. Himmelsbach has been appointed chief of the Division of Hospitals, Public Health Service, U.S. Department of Health, Education, and Welfare. Since July 1953, as assistant chief of the division, Himmelsbach has served under Assistant Surgeon General G. Halsey Hunt, whose duties as associate chief, Bureau of Medical Services, included those of chief, Division of Hospitals.

Himmelsbach will have charge of the 16 hospitals and 125 outpatient clinics and offices for legal beneficiaries of the Public Health Service. This nationwide system of medical care facilities includes the hospitals at Lexington, Ky., and Fort Worth, Tex., for treating narcotic addicts, and the hospital at Carville, La., for patients with leprosy.

John H. Garlock of New York, who is at present on a teaching tour of Japan, has been made an honorary fellow of the Chiba Medical Congress and the Tokyo Surgical Congress.

On 16 Feb. a portrait of **Elmer Verner McCollum,** one of the founders of nutritional biochemistry in this country and professor emeritus of biochemistry at Johns Hopkins University, was presented to the Welch Medical Library of that university. Colleagues, former students, and friends combined to provide for the portrait, which was painted by Paul Trebilcock of New York. Approximately 150 guests attended the ceremonies, and two of Dr. McCollum's closest friends, Edwards A. Park, professor emeritus of pediatrics at the Johns Hopkins Medical School, and Lowell J. Reed, president of Johns Hopkins University, spoke about him.

S. R. M. Reynolds, of the department of embryology at the Carnegie Institution of Washington, Baltimore, Md., left 15 Mar. to serve as visiting professor on the faculty of medicine, Montevideo, Uruguay, and on the medical faculty of the University of Recife, Recife, Brazil. He will lecture, hold seminars, give demonstrations, and participate in research programs at both institutions.

M. H. Thornton, until recently director of chemical sciences for Midwest Research Institute, Kansas City, Mo., has been appointed to the newly created post of technical director. All research and development activities will be coordinated under his direction. Thornton has worked on dehydrated foods, basic studies of fats and oils, development of analytical methods, and identification of biologically important glucosides. In cooperation with the U.S. Department of Agriculture, he has developed many new commercial uses for soybean products; he also holds a number of patents on industrial production of plant sterols and plant phosphatides.

Charles C. Buck has been appointed assistant to the chief of the U.S. Forest Service's fire research division in Washington, D.C. **R. Keith Arnold** succeeds him as chief of forest fire research at the California Forest and Range Experiment Station in Berkeley.

Arthur E. Gabriel, formerly of Armour Research Foundation of Illinois Institute of Technology, has been appointed research project leader for the Evans Research and Development Corp., consulting chemists of New York City.

Joseph Greenberg of the section on chemotherapy, Laboratory of Tropical Diseases, National Institutes of Health, has received the Bailey K. Ashford award, consisting of a medal and $1000, in recognition of his work on the mode of action of antimalarial agents. He was honored during the annual meeting of the American Society of Tropical Medicine and Hygiene in Memphis, Tenn.

With the aid of a combined Guggenheim-Fulbright award **Kenneth E. Caster,** professor of geology at the University of Cincinnati, will join the faculty of the University of Tasmania as visiting professor from September 1955 to June 1956. He plans to continue his work on fossils of the Devonian and Silurian periods.

The following mathematicians have been appointed to assistant professorships: **Dean C. Benson** of Iowa State College, to South Dakota School of Mines and Technology; **W. P. Brown** of the University of Michigan, to Michigan State College; **M. D. Davis** of the Institute for Advanced Study, to the University of California, Davis; **E. F. Gillette** of Syracuse University to Harpur College, State University of New York; **E. E. Posey** of the University of Tennessee, to West Virginia University.

Meetings

Three days of scientific papers, panel discussions, and special lectures on pulmonary diseases will mark the 50th anniversary meeting of the **American Trudeau Society,** medical section of the National Tuberculosis Association, beginning 23 May in Milwaukee, Wis. The meeting is being held in conjunction with the annual meeting of the NTA. All sessions will be in the Milwaukee Auditorium. The chemotherapy and other medical aspects of treatment of tuberculosis, the surgical management of tuberculosis and related diseases, and current research will be discussed by specialists from all sections of the country.

The committee in charge of arranging the medical program was under the chairmanship of David T. Carr of Rochester, Minn. John D. Steele of Milwaukee is president of the American Trudeau Society. For information write NTA, 1790 Broadway, New York 19.

As part of the annual meeting of the **Tissue Culture Association** in Philadelphia, 5–6 Apr., botanists interested in the study of excised plant cells and organs are invited to participate in a session on the afternoon of 5 Apr. called "Current research in plant tissue cultures." The chairman will be Philip R. White of the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Me. Scheduled speakers are Wm. G. Boll,

University of Texas; John G. Torrey, University of California; Ralph H. Wetmore, Harvard University; F. C. Steward, Cornell University; Louis G. Nickell, Chas. Pfizer & Co.; Ernest Boll, North Carolina State College; Carl D. LaRue, University of Michigan; Jakob Reinert, Roscoe B. Jackson Memorial Laboratory; and Armin C. Braun, Rockefeller Institute.

Plans for a **Conference on Nuclear Engineering** to take place at the University of California, Los Angeles, 27–29 Apr., have been announced by T. J. Connelly of the university's department of engineering. Topics to be covered are water and liquid metals as primary working fluids, boiling water reactors, radiation sources for industrial applications, and power reactor control during load changes. At a dinner session the speaker will be John von Neumann of the Institute for Advanced Studies and nominee to the Atomic Energy Commission. For information write to the University of California Extension, Los Angeles 24.

The 26th annual meeting of the **Aero Medical Association** will take place 21–23 Mar. at the Hotel Statler in Washington, D.C. More than half of the meeting's 40 scientific presentations will be devoted to military aspects of aviation medicine and flying safety.

A symposium on the newest developments in the field of space medicine, and a round-table discussion of the aeromedical aspects of flight at extreme speed and altitude will be presented by a group of outstanding test pilots.

The first Louis H. Bauer lecture, established in honor of the association's founder and first commandant of the U.S. Air Service School of Aviation Medicine from 1919–1925, will be presented on 21 Mar. by John F. Fulton, physiologist and Sterling professor of the history of medicine at Yale University. Sen. Stuart Symington, who served as first Secretary of the Air Force, will be guest of honor and principal speaker at the society's annual dinner on 23 Mar.

The 13th annual meeting of the **American Association for Cleft Palate Rehabilitation** will meet at the Hotel Statler in Boston, 13–14 May. This meeting will be open to nonmembers. Papers will be presented and symposiums held on topics in the medical, dental, speech, psychological, educational, sociological, and other aspects of cleft palate rehabilitation. Individuals interested in presenting papers or organizing symposiums should write to the program chairman, Dr. Alex Fox, 1653 Main St., Springfield, Mass.

The 20th **Cold Spring Harbor Symposium on Quantitative Biology** will be held 6–13 June on the general theme "Population genetics: the nature and causes of gentic variability in populations." Population genetics is an active but divided branch of genetics. Agricultural geneticists and evolutionary geneticists who study populations have each made rapid progress in the development of theory and experimental techniques. The objective of this year's symposium is to bring leading workers together in an effort to establish an area of agreement on fundamental concepts common to both divisions of population genetics. If such an agreement can be reached, the rapid exploitation of advances in one division by workers in the other will be facilitated.

Discussions will focus on the following topics: general theory of population genetics, theory of quantitative genetics, selection in plants, selection in animals, genetic variability and polymorphism, populations in time and space, and integration of genotypes. Among the invited participants will be 30 from outside the United States, including Belgium, Brazil, Chile, France, Great Britain, Italy, Japan, Spain, Sweden, and Yugoslavia, as well as Africa and Australia.

This year's meeting is being sponsored by the Carnegie Corporation of New York, the National Science Foundation, the U.S. Atomic Energy Commission, the Association for the Aid of Crippled Children, and the Rockefeller Foundation. The symposium is open to all who are interested, but because of space limitations it is important to make reservations. For program and information address the Biological Laboratory, Cold Spring Harbor, N. Y.

The 28th meeting of the **American Association of the History of Medicine** will take place 12–14 May in the Park Shelton Hotel, Detroit, Mich. Alfred H. Whittaker of Detroit is chairman of the committee on local arrangements, and Erwin H. Ackerknecht, professor of the history of medicine at the University of Wisconsin, is chairman of the committee in charge of arranging for the papers on the program. For information, write to either of these men or to the secretary, Dr. Samuel X. Radbill, 7043 Elmwood Ave., Philadelphia 42, Pa.

The question of how to provide for an adequate supply and for the proper utilization of the nation's technological manpower resources has been the subject of much concern since World War II and has been the motivation for many conferences and discussions. Such meetings have most frequently been held by and for persons with a close personal interest in the subject.

A **military-industrial conference,** sponsored primarily by the Society of American Military Engineers, took place 10–11 Feb. in Chicago. The theme of the program was "How can our technical manpower be best utilized in the interests of our national welfare"?

Joining in the sponsorship of this meeting were commercial and industrial organizations such as the Chamber of Commerce of the United States and the National Association of Manufacturers, governmental agencies, including the Department of Defense and the Industrial College of the Armed Forces, and a substantial number of professional societies in the engineering and scientific fields. The conference was, therefore, different, in that the majority of the sponsoring agencies had no immediate selfish motivation. The attendance at the meeting was somewhat extraordinary, considering that it included persons from

the highest management positions in a cross section of leading American industries as well as top-level persons from Government, the services, and the major professional societies. More than 1000 individuals participated in the conference.

The program for the first day was largely a review of the present manpower situation with its implications for the future of industry, the military services, and education. The program on the second day was largely devoted to discussion periods based on questions from the participants.

No action from the conference had been contemplated, since to most of the participants the subject was to some extent new. The value of the conference lay in the fact that, to a very large and important segment of the leadership of American industry and the services, a thorough analysis of the problems of technological manpower was presented for their orientation.

The conference attracted a great deal of attention and newspaper comment. It is expected that the proceedings will be printed and widely distributed so that further benefit may accrue.—M. H. TRYTTEN.

Health officials from 24 nations met in Paris in February to revise the international method of recording diseases, injuries, and causes of death. The conference was sponsored jointly by the World Health Organization and the French Government.

The 2nd **Interamerican Congress of Psychology** took place in Mexico's new University City, 14–19 Dec. 1954. The central theme was the psychology of education from the points of view of applied psychology, social anthropology, psychotherapy, and teaching. Delegates from various Latin American countries, the United States, and Canada, as well as special representatives of the American Psychological Association, were invited guests of the congress committee and its sponsors, the Department of Education and the National University of Mexico.

This congress, which had approximately 150 participants, again gave a survey of psychological and educational work done in the various countries, as illustrated by Blumenfeld from Peru, Donaire from Honduras, Jarquin from Mexico, Knobel from Argentina, Malmo from Canada, Olsen from the United States, and others. Psychotherapists such as Devereux, Fromm, Millan, Pascual del Roncal, Pearlman, Schwartz, and Wolff commented upon educational problems in psychotherapy. The Mexicans illustrated their growing psychotherapeutic program by arranging visits to the Mental Hygiene Clinic, the Medical Center for the Rehabilitation of Exceptional Children, and the Psychiatric Service of the Children's Hospital.

Social-anthropological aspects of education were discussed by Abel, Harold and Gladys Anderson, Devening, and others. Latin American contributions illustrated cultural differences in the manifestation and frequency of psychological traits and disturbances.

The symposium on education and applied psychology included contributions about the role of projective and other tests and the functions of memory and intelligence, by Bunch, Harrower, Palacios. The Latin Americans discussed the use of Rorschach drawings, the new tests of Meili, and so forth, and a large exhibition illustrated the growing importance of diagnostic tools in Mexican schools.

Among the contributions to the symposium on the psychology of teaching were those on the application of psychology in the selection of teachers, on the psychology of teaching exceptional children, and on the training of clinical psychologists; participants included among others, Deutsch, Griffin, Kaback, Krawiec, Kroll, and Worcester. The Latin Americans presented observations on emotional problems of students, thought patterns in different age groups, the influence of school upon personality, and psychological problems of the curriculum. Visits to the Mexican Juvenile Court and to an Orientation Center illustrated Mexican practices of teaching. The latter institution unites children of superior and inferior intelligence having emotional difficulties, the superior ones helping their underdeveloped companions. The occupational therapy includes the children's printing their own books, farming, and painting.

The congress led to various resolutions. A constitution proposed by Willard C. Olson, president of the society, was adopted. Publication of the transactions, a directory of Latin American psychologists, a bibliography of psychology books published in the Spanish language, and a publication of the Interamerican Society of Psychology, as well as research exchanges, and possibilities for fellowships were offered and discussed.

The Atomic Industrial Forum and the Stanford Research Institute will jointly sponsor a meeting on **Atomic Energy—the New Industrial Frontier,** 4–5 Apr. at the Mark Hopkins Hotel in San Francisco. More than 500 industrial leaders from all over the country will attend.

The program will include discussions by Glenn Seaborg, Nobel prize chemist of the University of California; Bruce Morgan, technical director of the Quartermaster Corp's food sterilization program; Edward Teller, research physicist of the University of California; Jesse Johnson, director of the Atomic Energy Commission's raw materials division; Chauncey Starr, director of the atomic energy department of North American Aviation, Inc.; R. P. Peterson, director of atomic energy research for the Republic Steel Corp.; and Melvin Calvin, authority on photosynthesis.

The International Union of Biochemistry, which was founded on 1 Mar. 1953, was formally constituted at its first general assembly in London 5–6 Jan. Of the 15 countries that adhere to the union to date, the following 12 were represented at the assembly: Austria, Belgium, Denmark, France, Germany, Italy, Japan, the Netherlands, Sweden, the United King-

dom, the United States, and the U.S.S.R. In accordance with its statutes, the assembly elected the council of the union, and the council appointed from among its members the following officers: pres., M. Florkin (Belgium); treas., E. H. Stotz (U.S.A.); sec.-gen., R. H. S. Thompson (U.K.)

The following delegates make up the remaining members of the council: S. Akabori (Japan), J. Courtois (France), V. A. Engelhardt (U.S.S.R.), A. H. Ennor (Australian), O. Hoffman-Ostenhof (Austria), K. Linderstrom-Lang (Denmark), K. Lohmann (Germany), R. Nicolaysen (Norway), S. Ochoa (U.S.A.), A. I. Oparine (U.S.S.R.), Rudolph Peters (U. K.), J. Roche (France), A. Rossi-Panelli (Italy), A. Virtanen (Finland), and H. G. K. Westenbrink (Netherlands).

Charles Harington, former chairman of the International Committee for Biochemistry that was set up at the 1st International Congress of Biochemistry at Cambridge in 1949, was elected an honorary member of the council. Following the unanimous decision of the assembly, formal application has now been made on behalf of the union for membership in the International Council of Scientific Unions.

Education

Prompted by the announcement of Louisiana State University's initiation of the use of closed-circuit television as a regularly scheduled component of its current course in medical physiology [*Science* **121**, 237 (18 Feb. 1955)], a reader at **Albany Medical College** has written:

> . . . it was our own Dr. Frank Ferguson, chairman of the department of pharmacology, who introduced this method in September and October of 1954 in connection with certain techniques of laboratory procedure, as well as the projection of live experiments. . . . The demonstration was carried out each time with the class in the same room, so that both direct and television-screen observations might be made.

Educational television programs, developed for national distribution by the Educational Television and Radio Center, Ann Arbor, Mich., will be made available for classroom and other audio-visual purposes through an arrangement just completed with Indiana University. Under terms of the agreement, the university will serve as the national center for nontelevision distribution of these educational program materials. The project will be self-liquidating, with income from sales and rentals paying for the cost of the service.

By means of this service, benefits from educational television production will be extended to universities, colleges, school systems, and other educational agencies in every part of the nation. The programs available will include lectures, discussions, and illustrations of scientific and other developments in education.

The Indiana audio-visual department, which is headed by L. C. Larson, began the new service on 15 Feb. The center will continue to handle all television distribution of its programs. At the present time it is distributing programs on a regular basis to 11 educational television stations and to an additional four universities for use on local commercial stations in areas without ETV stations.

The University of Pennsylvania has received a grant of $25,000 from the Fels Fund to study policies and practices which contribute most effectively to the development of the **strongest possible faculty** working under the best possible conditions. The study, looking toward the development of an affirmative policy for faculty personnel, will be made by a committee of the university faculty that is under the chairmanship of David R. Goddard, professor of botany. The responsibility of the committee will involve both the initiation and conduct of its investigation and the recommendation of policies.

The department of geology of **Rice Institute**, Houston, Tex., is conducting a series of 25 public seminars that are being presented by a group of geologists, geochemists, geophysicists, and oil producers who have consented to serve as visiting lecturers.

After 30 June **Columbia University's** 5-yr-old Institute of Administrative Medicine will be merged into the university's 34-yr-old School of Public Health. The unit will be known as the School of Public Health and Administrative Medicine.

Available Fellowships and Awards

The department of zoology, Duke University, invites applications for the Charles W. Hargitt **fellowship in zoology.** The fellowship is awarded at the postdoctoral level in support of full-time research in cellular studies. The stipend varies with the qualifications and needs of the recipient, and is ordinarily from $4000 to $5000. The recipient has no departmental duties. Work may be done at Duke University and/or the Duke Marine Laboratory.

The present holder of the fellowship is Paul L. Risley, who is engaged in cytological research during a sabbatical leave from the department of biology, University of Oregon. Inquiries and applications should be addressed to Dr. H. S. Roberts, Department of Zoology, Duke University, Durham, N.C.

The **University of Vermont College of Agriculture** has announced that three graduate assistantships are available in biochemistry for 1955–56. These research grants allow half-time study for the M.S. degree. The work deals with plant growth stimulation, and the $1700 assistantships have been financed by the Atomic Energy Commission. For information, write Jack E. Little, Hills Science Building, University of Vermont, Burlington.

The State College of Washington has announced the allocation of funds for two postdoctoral research fellowships in the department of **poultry science**, effective 1 Sept. The stipend for each of these fellow-

ships is $4400 per year, $3600 of which is tax exempt.

The research problem for one of the fellowships relates to unidentified factors required for different strains of bacteria. Interested persons should have had training in chemistry and biochemistry.

The second fellowship is for turkey embryology. Applicants should have a background in physiology, biochemistry, and biophysics. For information, write to J. S. Carver, Chairman, Department of Poultry Science, State College of Washington, Pullman.

Miscellaneous

The **Council for Old World Archaeology,** first established at the 1951 annual meeting of the AAAS by Section H, has now completed its organization. An incorporated, nonprofit group, the council was set up primarily for the purpose of disseminating, through appropriate publications, findings concerning all Old World periods of cultural development that are investigated by archeological techniques. For this purpose, editors have been chosen for 22 areas. These editors will relay materials to four continental editors (for Europe, Africa, Asia, and Oceania, including Southeast Asia) who, in turn, will rely on an international roster of contributors. A chief editor will coordinate all material after it has been approved by the area and continental editors and will handle details of publication and distribution. Grants from the Wenner-Gren Foundation and from several individuals have provided sufficient funds to cover organizational operating costs and the first year's expenses of publishing area surveys and bibliographies.

Administratively, the council consists of a president, clerk, treasurer, executive committee, board of trustees, and a group of charter members who elect the officers and trustees. Lauriston Ward is currently serving as president. The council is the joint operating agency of the following well-established scientific societies: Section H of AAAS, American Anthropological Association, American Association of Physical Anthropology, American Numismatic Society, American Oriental Society, American School of Prehistoric Research, American Schools of Oriental Research, Archaeological Institute of America, Society for American Archaeology.

An **exhibit of chemicals and synthetics** sponsored by the U.S. Patent Office is on display in the lobby of the Commerce Department Building, Washington. The exhibit, which continues through 25 Mar., is designed to show the technological advances made by inventors and industries under the American patent system.

The new **American Astronautical Society** is exclusively devoted to the development of the astronautical sciences, which deal with all aspects of space-travel planning and theory. The society publishes a quarterly journal, *Astronautics*, which is available to the membership. It includes all material relevant to astronautics or space flight from general-interest level material to the most profound. All scientific fields are represented, that is, sociological, biological, and physiological as well as the technical fields closely related to the existing rocketry and missile sciences.

Through its journal, through meetings, symposiums, field trips, and so forth, the A.A.S. serves its members in all areas within the broad science of astronautics. The organization of the A.A.S. is similar to that of existing technical societies, and it is incorporated in the state of New York. The society is a member of the International Astronautical Federation.

With the assistance of the Society for Social Responsibility in Science and the Food and Agriculture Organization of the United Nations, Wilmington College plans to set up a Small Tools Laboratory and is **looking for a responsible engineer** to be in charge of this work. Since there is considerable latitude in the development of this project, engineers of any of several branches may be interested, but it is expected that mechanical or metallurgical engineers would be interested primarily.

It is essential that the applicants be in accord with the nature and purpose of the college, which is under the sponsorship of the Religious Society of Friends, and with the fact that the work will be intergovernmental in scope.

In carrying out this work, the activities of the college demonstration farm, the nearby Ohio State University with its agricultural and engineering departments, and the strong engineering libraries of the Fels Memorial Institute, Antioch College, and the University of Cincinnati will be helpful. The salary range under consideration is from $5000 to $6000 per year. For further information, write to Samuel D. Marble, President of Wilmington College, Wilmington, Ohio.

Academic Press, Inc., New York, has announced a new journal, ***Virology,*** for which the following scientists have accepted editorial responsibility: George K. Hirst, Public Health Research Institute of the City of New York, Inc. (editor-in-chief); L. M. Black and S. E. Luria, University of Illinois, Urbana, (editors); C. H. Andrewes, C. A. Brandly, Seymour S. Cohen, A. H. Doermann, John F. Enders, Charles A. Evans, Werner Henle, A. D. Hershey, Francis O. Holmes, Frank L. Horsfalls, Jr., Hilary Koprowski, Andre Lwoff, James W. Moulder, Glenn S. Pound, Theodore T. Puck, A. F. Ross, H. K. Schachman, Edward A. Steinhaus, Robley C. Williams, C. E. Yarwood (associate editors).

The purpose of *Virology* will be to publish articles on the biological, biochemical, and biophysical aspects of the subject, stressing articles of a fundamental rather than an applied nature. It is hoped that the journal will contribute to the integration of virus science by providing a ready introduction to all its fields.

Erratum. William L. Thomas, Jr., is assistant director of research at Wenner-Gren Foundation for Anthropological Research and not at the National Science Foundation, as is stated in *Science*, 11 Mar., page 357. Paul Fejos is director of research at Wenner-Gren and not at NSF, as is implied in the same issue.

Book Reviews

Effects of Electricity on Muscular Motion. Luigi Galvani. Trans. by Margaret Glover Foley. Burndy Library, Norwalk, Conn. 1954. 176 pp. Illus. + plates. $6.

This fine volume is the 10th publication in the Burndy Library series. It contains an English translation of Galvani's celebrated Latin monograph *De Viribus Electricitatis in Motu Musculari,* first issued in 1791, together with a facsimile reproduction of the original text. Margaret Foley supplies a clear and vigorous rendering of Galvani's rather complicated phraseology. I. Bernard Cohen has written an admirable introduction. By an unusual coincidence two English translations of the full text appeared within a few months of each other—the present volume and that prepared by Robert Montraville Green (Elizabeth Licht, Boston, 1953). Prior to this time only partial translations have been available, in particular the fragment published in 1935 by William Francis Magie.

A reading of the introduction and full text corrects certain misapprehensions that have been widely held concerning the scope and significance of Galvani's work. He was not the first to stimulate nerves and muscles with electric current. Earlier students, using discharges from the Leyden jar, or of atmospheric electricity, had observed such stimulation. Neither was he the first to detect animal electricity. John Walsh had demonstrated the electric character of the shock of *Torpedo* in 1774. Galvani's major contributions were, first, his observation that electric currents, generated by friction machines or by thunderstorms, could induce electric flow in metal conductors at some distance from the primary source, and, second, his discovery that pairs of dissimilar metals could excite living tissues.

The first discovery was not properly understood either by Galvani or by his contemporaries. He described with great enthusiasm the many ways in which he could stimulate nerves and muscles by touching them with metallic objects, scalpels, rods, or wires, in the vicinity of a frictional electric machine. With each spark contraction occurred, the living tissues acting as sensitive galvanometers to indicate current. He seems to have had clearly in mind the concept of electric induction, although he could not describe the phenomenon in modern terms and is not credited with its discovery. Forty years later Faraday discovered the phenomenon in all-metallic systems and inaugurated the modern electrical age.

His second discovery grew out of the first but revealed phenomena of a quite different character. He observed that, in the absence of a frictional machine or atmospheric electricity, he could stimulate nerve and muscle by touching them at two points by his "arcs" made by joining two dissimilar metals together. These curving metallic couples are a prominent feature of his illustrations. He believed that he thus led off electric charges that had accumulated in the tissues and thought that he had demonstrated the reality of animal electricity. Volta immediately built upon this work, shortly to reveal the existence of electrode potentials and to combat Galvani's interpretation. It is evident that Galvani did not clearly demonstrate animal electricity, but his faith in it was later vindicated in the growth of modern electrophysiology.

Galvani stands out in the stream of scientific history as a somewhat confused and neglected figure, yet one who, by his striking experimental demonstrations, compelled the attention of workers in several disciplines and opened the door to many fundamental discoveries. The present volume helps to bring his observations into proper focus and permits us to appreciate better the enthusiasm and devotion that he gave to his important pioneer work.

WILLIAM R. AMBERSON
Department of Physiology,
University of Maryland School of Medicine

The Distribution and Abundance of Animals. H. G. Andrewartha and L. C. Birch. Univ. of Chicago Press, Chicago, 1954. xv + 782 pp. Illus. $15.

The relatively new scientific field of animal ecology has, by now, split into two major divisions. Of these, in contrast with the more traditional ecology of communities, the newer is the ecology of individual species and populations. In recognizing this cleavage between methods and knowledge, the authors did not minimize the importance of the community approach in their own emphasis of the other; it is only that they undertook to explore and synthesize a literature that greatly needed exploration and synthesis, in order "to build a wide and satisfying general theory of ecology as we use the word to refer to the distribution and abundance of animals in nature."

Invertebrates, notably insects, furnish most of the examples of populations, and the original contributions of both authors are primarily entomologic, but the scope of the book nevertheless is about as broad as our collective knowledge of animal populations permits. Despite the obvious intentions of the authors to present the subject matter as simply, clearly, and logically as would be consistent with a comprehensive treatment—and in which I think they have succeeded—the natural complexities that are involved effectively limit the extent to which the subject matter may be simply presented. This is no book that any serious student of populations should read once and then consider himself through with; he should have convenient access to it for as many readings of particular parts as his own studies may require.

It is written for mature workers who can do their own thinking and, to them, it should be of outstand-

ing utility. Most practicing biologists may find more mathematics in it than they can easily digest, although they may be comforted by the authors' cautioning against *misuse* of mathematics (p. 11). Others may feel that some conclusions are presented a little too confidently, with insufficient allowance being made for alternative interpretations or for the still unknown. My impression, however, is that the tone of the writing is reasonable, good natured, and objective, and that certainly much of what is demolished is philosophically shaky anyway.

In appraising the factual content, I paid special attention to the parts dealing with the groups of higher vertebrates that I happen to have worked with, and, on the whole, feel satisfied with what I read there. Very nearly all the exceptions to the treatment of higher vertebrates that I would be disposed to take have to do either with minor points or with those about which no one has, as yet, conclusive answers, and about which some legitimate disagreement may be expected for a long time to come.

The book shows evidence of continued revision and probably came off the press in an exceptional state of up-to-dateness for such a big job in a difficult and rapidly advancing field.

PAUL L. ERRINGTON
Zoology and Entomology Department, Agricultural Experiment Station, Iowa State College

Entire Functions. Ralph Philip Boas, Jr. vol. V of *Pure and Applied Mathematics.* Paul A. Smith and Samuel Eilenberg, Eds. Academic Press, New York, 1954. xi + 276 pp. $6.

The theory of entire functions is a vast, rich chapter in the general theory of functions of a complex variable. Its literature is tremendous. The bibliography of the present monograph, which is concerned principally with the special class of entire functions of exponential type, consists of 17 pages. Intentionally, many topics of the general theory of entire functions, such as the Picard theorem and its developments, are omitted in this monograph. The result of this imposed restriction is a unity of theme and method. The interest of the special class of entire functions of exponential type is, of course, well known. As the author remarks, an account of the applications of functions of exponential type would call for a book by itself. What has been achieved here is a comprehensive account of the modern theory of functions of exponential type. The book is a valuable addition to the existing monographic literature on the theory of functions of a complex variable and is to be warmly recommended to both specialist and student.

The reader is expected to have a knowledge of the elements of the theory of analytic functions, including the theorems of Jensen, Carleman, and Phragmèn-Lindelöf, as well as some knowledge of the theory of subharmonic functions and of Lebesgue and Stieltjes integrals.

A summary of the contents follows: "Preliminaries"; "General properties of entire functions of finite order"; "The minimum modulus"; "Functions with real negative zeros"; "General properties of functions of exponential type"; "Functions of exponential type restricted on a line: I, Theorems in the large"; "Functions of exponential type restricted on a line: II, Asymptotic behavior in a half plane"; "Functions of exponential type: Connections between growth and distribution of zeros"; "Uniqueness theorems"; "Growth theorems"; "Operators and their extremal properties"; "Applications."

MAURICE HEINS
Department of Mathematics, Brown University

Progress in the Chemistry of Organic Natural Products. vol. 10. L. Zechmeister, Ed. Springer, Vienna, 1953. ix + 529 pp. Illus. Paper, $19; cloth, $19.80.

This, the tenth volume of the Zechmeister series, follows the excellent tradition of the previous volumes with regard to the choice of subject matter and clarity of presentation. The authors, experts in their fields, have succeeded in conveying a well-rounded picture of the complexity and importance of the subject matter.

The first chapter, by K. Adler and M. Schumacher, deals with the applications of the "Diene synthesis" to the elucidation of the formation and constitution, as well as to the preparation, of natural products. The tremendous progress in this field becomes quite apparent if one compares the 347 references cited in this work with the 44 cited by O. Diels who covered the same topic in 1939 for the third volume of this series.

H. Mark discusses the physical chemistry of rubbers in the second chapter. The author utilizes only a minimum of mathematical equations in his presentation and treats, among other topics, the fundamental aspects of rubberiness, the structure of natural and synthetic rubbery polymers, and the kinetic theory of rubber elasticity.

The third chapter, by J. Asselineau and E. Lederer, treats the chemistry of the lipoids of bacilli. The various compounds that have been isolated from bacilli are enumerated, and structure proofs and syntheses are presented.

Syntheses of cortisone and related compounds are reviewed in a chapter by G. Rosenkranz and F. Sonderheimer. The authors give a number of useful charts in their discussion of the highly complex chemistry; they have covered the literature up to 1952.

The final two chapters, by A. Chatterjee and by L. Feinstein with M. Jacobson, deal, respectively, with the alkaloids of Rauwolfia plants and with the insecticidal principles of higher plants.

Not only researchers in the various fields presented but also all those who are interested in gaining a better insight into the complexity of natural products will profit from this volume.

HENRY FEUER
Department of Chemistry, Purdue University

The Language of Taxonomy. An application of symbolic logic to the study of classificatory systems. John R. Gregg. Columbia Univ. Press, New York, 1954. ix + 70 pp. Illus. $2.50.

Taxonomy is the study of kinds of organisms. One of the procedures used in dealing with kinds is classification. Recent advances in genetics and the rise of the science of ecology have resulted in a current interest in taxonomy on a much broader plane than was historically the case. With this increased interest has come a series of new difficulties caused by the use of certain words of inexact meaning or varying implication. Attempts at definition have not clarified the situation; indeed, in some cases they have further confused it.

John Gregg's book is an attempt to develop a language for use in metataxonomy—the study of statements about taxonomy—by introducing the concepts of set-theory, which is one of the symbolic methods of formal logic. These concepts seem suited to the study of classifications, where they can emphasize the distinctions between kinds, classes of kinds, and categories of classes. Failure to distinguish these has been the cause of much semantic difficulty, with resultant confusion of thinking.

In order to show the application of set-theory to metataxonomy, Gregg has developed the appropriate set-theory concepts in the early chapters. Thus, an interested student will find the book self sufficient although highly technical. It concludes with the presentation of a problem for further study—the complications introduced by category overlapping (class A includes only one order, b, and therefore A and b are identical groups and the categories are overlapping). This difficulty appears to be a result of certain short cuts commonly used in writing down classifications. If it can be shown that the difficulty is not real, then further development of this language will be facilitated, and solution of some of the practical problems of taxonomic language may be undertaken.

R. E. Blackwelder
Society of Systematic Zoology, Washington, D.C.

Recent Progress in Hormone Research. vol. X. Proceedings of the Laurentian Hormone Conference. Gregory Pincus, Ed. Academic Press, New York, 1954. 511 pp. Illus. $9.80.

This volume contains the proceedings of the tenth annual meeting of the Laurentian Hormone Conference, which took place in September 1953, at Mont Tremblant, Quebec. Six major topics are reviewed, namely: (i) nervous system, hormone interrelationships (R. W. Porter, H. Hoagland, D. M. Woodbury); (ii) thyroid hormone physiology and biochemistry (J. Gross, R. Pitt-Rivers, H. A. Lardy, G. F. Maley); (iii) comparative endocrinology (D. Bodenstein, E. Scharrer, B. Scharrer); (iv) protein hormones (R. G. Romans, E. E. Hays, W. F. White); (v) the role of hormones in blood and blood-forming organs (H. S. Kaplan, C. S. Nagareda, M. B. Brown, A. S. Gordon); (vi) aspects of clinical endocrinology (B. Zondek, R. Luft, B. Sjögren, D. Ikkos, H. Ljunggren, H. Tarukoski, J. W. Conn, S. S. Fajans, L. H. Louis, H. S. Seltzer, H. D. Kaine).

Endocrinologists throughout the world are particularly indebted to Gregory Pincus for the thoughtful preparation, both of the conferences themselves and of the printed proceedings, which make the former more generally available. It is a particularly attractive feature of these proceedings that they contain not only the formal papers (presented by the authors listed here) but also transcripts of the informal discussions made by various other participants following each presentation.

It would, of course, be impossible to give anything like a summary of such a complex symposium, but since all the speakers are eminently competent authorities in their respective fields, there can be no doubt about the value of this volume. The type, illustrations, and binding are excellent, and the book is supplied with carefully prepared indexes of authors and subjects.

Hans Selye
Institut de Médecine et de Chirurgie expérimentales, Université de Montréal

Traité de Génétique. Ph. L'Héritier, Presses Universitaires de France, Paris, 1954. *Le mécanisme de l'Hérédité. Génétique formelle,* Tome I, 343 pp. Illus. F. 1500; *La Génétique des Populations,* Tome II, 173 pp. Illus. F. 900.

The publication of a new textbook of genetics in the French language is a matter of more than ordinary interest, since, in the opinion of many who are in a good position to judge, the lack of adequate textbooks has been a real handicap to the teaching of genetics in France. L'Héritier's *Traité de Génétique* will undoubtedly go a long way toward filling this vacuum and will give welcome support to the general awakening of interest in genetics that has been evident in France since the war.

Traité de Génétique is projected in three volumes of which two have now been published. The third volume, dealing with physiological genetics, is in preparation. Volume I is concerned with the formal aspects of chromosomal inheritance. It is an exposition of classical genetics that is almost unique in its purity of approach. The author's aim, judging from the result, is to present the principles of genetics and the evidence on which they are based in their most logical and economical form. We find no chapters on derivative aspects of genetics, such as medicolegal applications, clinical heredity, sociologic implications, and similar topics that have been found useful in bolstering up the sagging attention of premedical students. The examples, chosen for their soundness as evidence, rather than on the basis of their exotic value, are drawn almost entirely from the literature of the well-studied genetic organisms, especially *Drosophila*. In

other words, this book is intended for the instruction of students who are already convinced that genetics is an interesting subject and who wish to get a professional insight into its theoretical foundations. It is probably too difficult for any but the most inspired beginners.

Volume II is devoted to population genetics, a subject in which the author has long had a special interest. The first chapter deals with the mathematics of genetically stable populations under panmictic and assortative systems of mating. The second analyzes the roles of selection, mutation and migration, and chance fluctuation as causes of changes in gene frequency, the treatment closely following that of Sewall Wright. The third and final chapter contains a summing up of the neo-Darwinian view of evolution and a discussion of the genetic definition of species. The presentation is lucid and careful throughout.

Each chapter in both volumes is followed by a list of selected references. It is to be hoped that the third volume will contain an index.

N. H. Horowitz
Laboratoire de Génétique, Faculté des Sciences, Paris

Analytic Geometry. Edward S. Smith, Meyer Salkover, and Howard K. Justice. Wiley, New York; Chapman & Hall, London, ed. 2, 1954. xiii + 306 pp. Illus. $4.

A statement in the preface indicates that the following changes of the first edition have been made in this edition: (i) revised problems; (ii) new articles on analytic proofs of geometric theorems and on cylindrical and spherical coordinates; (iii) improved treatment of the angle between two lines, excluded values, asymptotes, bisector of an angle, tangent to a circle, radical axes, and parametric form of the equations of a line; and (iv) a four-place table of trigonometric functions, with angles in radians and degrees.

This book constitutes a very thorough treatment of all the topics usually found in analytic geometry courses. Following the treatment of the straight-line and conic sections in type forms, space is devoted to the general equation of the second degree, tangents and normals, transcendental curves, polar coordinates, parametric equations and empirical equations. There follows a section in "Solid analytic geometry," which treats the line, plane, locus problems, and the quadric surfaces in type forms. If sufficient time can be allowed to do the textbook in its entirety, much time could be saved in the calculus courses by making it unnecessary to review, or to give for the first time, topics that are well covered here. A well-rounded course of shorter duration can be selected from the book without loss of continuity. Any student who continues in mathematics beyond the course in analytic geometry will find this to be an excellent reference.

Two chapters seem worthy of particular mention. One is given to a careful description of the intersection of a cone by a plane. The relation of the position of the interesecting plane to the definitions of the conic sections as loci is shown by careful drawings and explanations. The chapter on empirical equations is concerned with fitting curves to given sets of data and emphasizes the straight-line formula, the power law, the exponential law, and the parabola.

The book contains a large number of exercises of varying degrees of difficulty. Nearly all the exercises are geometric, and one might hope for some applications to problems arising in the physical sciences and engineering. Explanatory drawings are plentiful and carefully made. The format is pleasing, important formulas are in boldface type, and theorems and statements of particular emphasis are in italics.

J. A. Cooley
Department of Mathematics, University of Tennessee

Heterocyclic Compounds with Indole and Carbazole Systems. Ward C. Sumpter and F. M. Miller. vol. VIII of *The Chemistry of Heterocyclic Compounds.* Arnold Weissberger, Ed. Interscience, New York–London, 1954. xii + 307 pp. Single copy, $10; subscription, $9.

In this monograph the authors have undertaken "to present a thorough and comprehensive treatment of the methods of preparation, the properties, and the reactions of these compounds without attempting to duplicate the coverage of Beilstein (or of Elsevier's *Encyclopedia* when completed) by listing every compound." The result is a volume that lacks the completeness of its predecessors, but it does enable one to gain a background of information quickly.

The volume suffers from inadequate editing with respect to style, nomenclature, typographical errors, and organization of material, as the following random examples show. Page 61, "Indolenines of the type of 2,3,3-trimethylindolenine yield dimers on treatment with Grignard reagents, [335] the compound behaving as though it had the formula I." Page 54, "2-Methylindolemagnesium bromide reacts similarly . . . while 3-methylindolylmagnesium bromide gives. . . . On page 80, line 2, a sentence begins without capitalization and on line 8 of page 81 an "of" is omitted. On page 31, the arsonic acids derived from indoles are found under the heading "Halogen derivatives of indole." Fortunately, these errors are for the most part annoying rather than misleading.

The strength of the volume is in Chapter VIII, a 90-page discussion that brings together a mass of material on the many and varied naturally occurring products that contain an indole nucleus.

A. H. Blatt
Department of Chemistry, Queens College

New Books

Industrial Detergency. William W. Niven, Jr., Ed. Reinhold, New York 22, 1955. 340 pp. $8.75.

Degradation of Vinyl Polymers. H. H. G. Jellinek. vol. III of *Physical Chemistry.* Eric Hutchinson, Ed. Academic Press, New York 10, 1955. 329 pp. $8.50.

Colchicine—in Agriculture, Medicine, Biology, and Chemistry. O. J. Eigsti and Pierre Dustin, Jr. Iowa State College Press, Ames, 1955. 470 pp. $5.

Adrenal Cortex. Transactions of the fifth and final conference. Elaine P. Ralli, Ed. Josiah Macy, Jr. Foundation, New York, 1954. 187 pp. $3.75.

Anthropology. J. E. Manchip White. Philosophical Library, New York 16, 1955. 191 pp. $2.75

Arthritis and Radioactivity. A story of Montana's free enterprise uranium-radon mine. Wade V. Lewis. Christopher, Boston 20, 1955. 168 pp. $2.50.

Political Thought. C. L. Wayper. Philosophical Library, New York 16, 1954. 260 pp. $3.75.

Medical Care for Tomorrow. Michael M. Davis. Harper, New York 16, 1955. 497 pp. $6.50.

Tables of Functions and of Zeros of Functions. Collected short tables of NBS Computation Laboratory. NBS Applied Mathematics Ser. 37. Natl. Bur. of Standards, Washington 25, 1954 (Order from Supt. of Documents, GPO, Washington 25). 211 pp. $2.25.

Spies at Work. A history of espionage. Ronald Seth. Philosophical Library, New York 16, 1954. 234 pp. $4.75.

Language in Relation to a Unified Theory of the Structure of Human Behavior. pt. I. Kenneth L. Pike. Summer Inst. of Linguistics, Glendale, Calif. 1954 (Order from Wahr's Bookstore, 316 S. State St., Ann Arbor, Mich.). 170 pp. Paper, $5.

Fact, Fiction, and Forecast. Nelson Goodman. Harvard Univ. Press, Cambridge, Mass., 1955. 126 pp. $3.

Advances in Protein Chemistry. vol. IX. M. L. Anson, Kenneth Bailey, and John T. Edsall, Eds. Academic Press, New York 10, 1954. 542 pp. $10.50.

Ferns of Tennessee. With the fern allies excluded. Jesse M. Shaver. George Peabody College for Teachers, Nashville 5, 1954. 502 pp. $6.

Hopi Ethics. A theoretical analysis. Richard B. Brandt. Univ. of Chicago Press, Chicago 37, 1954. 398 pp. $7.50.

Catalysis. vol. II, pt. 2, *Fundamental Principles.* Paul H. Emmett, Ed. Reinhold, New York 22, 1955. 473 pp. $12.

The Western-Educated Man in India. A study of his social roles and influence. John Useem and Ruth Hill Useem. Dryden, New York 19, 1955. 237 pp. $3.

The Nihilism of John Dewey. Paul K. Crosser. Philosophical Library, New York 16, 1955. 238 pp. $3.75

My Way of Becoming a Hunter. Robert H. Rockwell with Jeanne Rockwell. W. W. Norton, New York, 1955. 285 pp. $3.75.

Truth and Freedom. Louis de Raeymaeker and other professors of the University of Louvain. vol. 5 of Duquesne Studies, Philosophical Ser., Andrew G. Van Melsen and Henry J. Koren, Eds. Duquesne Univ.; Pittsburgh 19, Eng. ed. 1, 1954. 133 pp. Cloth, $3; paper, $2.25.

Sociological Theory. Its nature and growth. Nicholas S. Timasheff. Doubleday, Garden City, N. Y., 1955. 328 pp. $4.50.

Physical Chemistry. College Outline Ser. No. 97. Scott L. Kittsley. Barnes and Noble, New York 3, 1955. 209 pp. Paper, $1.50.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to *Science*, but to the publisher or agency sponsoring the publication.)

Nivel de Fertilidad de los Suelos de la Sabana de Bogota. Boletin No. 1. Luis A. Rojas-Cruz. Laborantorio Quimico Nacional, Bogota, Colombia, 1954. 55 pp.

National Science Foundation. Fourth annual report for the fiscal year ending 30 June 1954. The Foundation, Washington 25, 1954 (Order from Supt. of Documents, GPO, Washington 25). 138 pp. $0.50.

Science and Religion: A Changing Relationship. Rede Lecture for 1954. C. A. Coulson. Cambridge Univ. Press, New York 22, 1955. 35 pp. $0.50.

Winter Key to the Woody Plants of the Northeastern United States and Adjacent Canada (Native and Exotic Species). Arthur Harmount Graves. The author, Wallingford, Conn., 1955. 33 pp. $1.35.

Oral Health Survey of Tristan da Cunha. Reidar Fauske Sognnaes. Results of the Norwegian Scientific Expedition to Tristan da Cunha, No. 24. Det Norske Videnskaps-Akademi, I Oslo, Norway, 1954. 145 pp.

Symposium on the Laboratory Propagation and Detection of the Agent of Hepatitis. Natl. Acad. of Sciences—Natl. Research Council, Washington 25, 1954. 115 pp. $1.

Further Studies on the Pleomorphic Microorganism Consistently Isolated from the Blood of Leprosy Patients (A Motile Rapidly Growing Form of Mycobacterium Leprae). Eleanor Alexander-Jackson. Reprinted from *Memoria del VI Congreso Internacional de Leprologia,* Madrid, 1953 (Copies obtainable from author, 390 Riverside Dr., New York 25). 11 pp.

Tree Improvement Research at the Lake City, Florida, Research Center: A Project Analysis. François Mergen and Kenneth B. Pomeroy. Sta. Paper No. 45, Southeastern Forest Expt. Sta., Asheville, N.C., 1954. 59 pp.

Bibliography of Syntheses with Carbon Isotopes. Compiled by Judd C. Nevenzel *et al.* Atomic Energy Commission, Oak Ridge, Tenn., 1954 (Order from Office of Tech. Services, Dept. of Commerce, Washington 25). 175 pp. $1.05.

Activities of the Texas Engineering Experiment Station for 1952–53 and 1953–54. Research Rpt. 50. Compiled by Arthur W. Melloh. Texas Engineering Expt. Sta., College Station, 1954. 40 pp.

A New Pictographic Autobiography of Sitting Bull. Smithsonian Misc. Coll. vol. 123, No. 6 Alexis A. Praus. Smithsonian Institution, Washington 25, 1955. 11 pp.

Report of the Mechanical Engineering Research Board. With the report of the director of mechanical engineering research for the year 1953. Her Majesty's Stationery Office, London, 1954. 64 pp. 2s. 6d.

The Hawaiian Chain. E. H. Bryan, Jr. Bishop Museum Press, Honolulu, 1954. 71 pp.

Environmental Physiology and Shelter Engineering. With special reference to domestic animals. XXIX. *Effect of Radiation Intensity on Hair and Skin Temperatures and on Respiration Rates of Holstein, Jersey, and Brahman Cattle at Air Temperatures 45°, 70°, and 80° F.* Research Bull. 561. Agr. Expt. Sta., Univ. of Missouri, Columbia, 1954. 35 pp.

Effect of Rainfall Characteristics and Soil Management Practices on Soil and Water Losses in Northwest Arkansas. Bull. 548. Agr. Expt. Sta., Univ. of Arkansas, Fayetteville, 1954. 54 pp. Gratis.

Technical Papers

Preliminary Notes on the Culturing of *Gymnodinium brevis* Davis

William B. Wilson and Albert Collier
U.S. Fish and Wildlife Service, Galveston, Texas

The mass mortality of fish off the west coast of southern Florida has attracted widespread attention since 1946. These catastrophes, commonly called Red Tides, have been associated with the high incidence of the marine dinoflagellate *Gymnodinium brevis* Davis (*1*) in the plankton populations (*2, 3*). Other investigators have reported conditions associated with these plankton blooms (*4–8*), but the study of this protist has been curtailed because of its sporadic occurrence in nature and the difficulty of maintaining it in laboratory culture.

Preliminary field investigations and culturing of a related species, *Gymnodinium splendens*, provided information that simplified the culturing of *G. brevis*. A medium composed of sea water, vitamin B_{12} (0.05 μg/100 ml), and Van Niel's (*9*) medium for sulfur bacteria (diluted 500 times) produced a culture containing more than 2500 cells of *G. splendens* per milliliter from an initial inoculum of two cells per milliliter in about 6 wk. *Gymnodinium brevis* responded better when the components of Van Niel's sulfur bacteria medium were diluted 1000 times and the vitamin B_{12} was increased to 0.1 μg/100 ml. The vitamin-B_{12} requirement of algal flagellates is discussed by Hutner and Provasoli (*10*). Vitamin B_{12} was required by dinoflagellates grown in pure culture by Provasoli *et al.* (*11*) and by Sweeney (*12*).

Using the latter medium as a base and a standard, we tested inorganic compounds, organic compounds, vitamins, and extracts of materials known to occur in nature, for example, soil and fish. By adding Florida peat extract, results were improved, but repeated experiments gave inconsistent results. A hot-water extract of beef liver further increased growth. We later substituted thiamine and biotin for the liver extract. The addition of the disodium salt of ethylenediamine tetraacetic acid (EDTA · Na), a metal buffer, (also designated ethylenedinitrilo tetraacetic acid disodium salt) increased the reliability of growth and resulted in the medium of Table 1. Soil extract, a more generally available material, can be substituted for Florida peat extract with a slight reduction in growth.

The conditions that we employed for culturing *G. brevis* are as follows: (i) Screw-cap test tubes 15 mm by 120 mm without liners were used for most experiments. Mass cultures are grown in erlenmeyer flasks and 5-gal Pyrex bottles with polyethylene covers (prepared by heating polyethylene sheet until soft and then molding over the mouth of the container). The glassware is cleaned by immersion in alcohol and sodium hydroxide solution, allowed to simmer 30 to 40 min in a solution of Cleaning Compound, No. 3298 (Arthur H. Thomas Co.), and rinsed 10 times with tap water and 15 times with distilled water. Extensive rinsing is employed since erratic results may be caused by minor contamination. (ii) Sterilization by steaming for 30 min on three successive days is optimum for the growth of *G. brevis*. McLaughlin (*13*) shortens the time by allowing 4-hr intervals between three 1-hr steaming periods without affecting growth results. Autoclaving produces erratic results. Growth is more consistent if inoculation is delayed for 4 days after sterilization. (iii) Aged sea water from the Gulf of Mexico [salinity, 36.5 parts per thousand (ppt)] was used in all experiments. The salinity of natural water containing high concentrations of *G. brevis* is usually between 32 and 34 ppt. A medium prepared according to Table 1 has a salinity of approximately 32 ppt. (iv) The temperature was usually maintained between 26° and 28°C, with as little variation as possible. (v) The *p*H stabilizes between 7.7 and 7.9 after sterilization. The *p*H of our aged sea water was between 8.1 and 8.2. The decreased *p*H is brought about by adding EDTA · Na. (vi) White daylight fluorescent tubes, 40-w, were used to maintain a light intensity of 175 to 300 ft-ca. (vii) Neither agitation nor aeration is required for growth. (viii) *G. brevis* was isolated into a unialgal culture in September 1953 and has been continuously subcultured since that time. Cultures usually reach maximum growth in 6 wk.

By substituting a group of trace metals (Fe, Zn, Mn, Sr, Rb, Mo, Co, Cu, Cr, Ti, Al, Si, and Zr) for soil extract, we obtained a medium that supports good initial growth of *G. brevis*, but continuous subculturing has not been successful. Titanium and zirconium were added to the mixture, although they are not normally present in measurable amounts in sea water (*14*), because these metals were found abundantly in water of *G. brevis* blooms (*7*).

Investigations led us to believe that heavy rainfall and subsequent river discharge are instrumental in

Table 1. Medium for the unialgal isolation of *G. brevis* Davis. After all additions are made, there is approximately 110 ml of medium.

Aged sea water (salinity, about 36.5 ppt)	95.0 ml
Distilled water*	5.0 ml
NH_4Cl†	0.1 mg
KH_2PO_4†	0.05 mg
$MgCl_2 \cdot 6H_2O$†	0.02 mg
$NaHCO_3$†	0.1 mg
$Na_2S \cdot 9H_2O$†	0.1 mg
Vitamin B_{12}	0.1 μg
Thiamine hydrochloride	1.0 mg
Biotin	0.05 μg
Soil extract‡	2.0 ml
EDTA · Na (6 ml of 0.25-percent solution)	15.0 mg

* More or less may be required, depending on the salinity.
† Added as 0.5 ml of the following solution of the components of Van Niel's medium for sulfur bacteria: NH_4Cl, 0.2 g; KH_2PO_4, 0.1 g; $MgCl_2 \cdot 6H_2O$, 0.04 g; $NaHCO_3$, 0.1 g; and $Na_2S \cdot 9H_2O$, 0.2 g to 1 lit of distilled water.
‡ Simmer for 40 min a mixture of 500 g of garden soil and 1 lit of distilled water. Let it stand for 4 days and decant the supernatant. Repeat simmering and decantation until extract is clear. Our soil gives a yellowish-brown extract.

initiating a bloom of *G. brevis* (*8, 15, 16*). On the basis of this belief, we conducted culture experiments whereby mediums were prepared by adding river water, extracts of peat soils from the western Florida coastal region, or both, to sea water from the Gulf of Mexico. Sea water containing 4 to 10 ml of river water per 100 ml supported limited growth of *G. brevis*. Seven to 10 ml of river water or peat extract per 100 ml of sea water is better, and peat extract or mixtures of peat extract and river water at this concentration are more productive than river water alone. The addition of vitamin B_{12} (0.05 μg/100 ml of medium) improved the reproducibility and growth.

The conditions in a bloom of *G. brevis* often led us to believe that fish which had been killed and subsequently decayed imparted nutrients that helped to perpetuate the bloom. We designed culture experiments to determine whether extracts of partially decayed fish promoted growth. The results of these experiments indicate that the extracts contain one or more growth-promoting substances. Robinson (*17*) lists fish, or portions thereof, as containing vitamins B_{12}, biotin, thiamine, and other B-complex vitamins.

Laboratory cultures of *G. brevis* have attained homogeneous concentrations exceeding 2 million cells per liter. This concentration is far below the highest report (*2, 3*); however, the values cannot be compared. Among other reasons, *G. brevis* in cultures concentrate to form masses that we disperse by shaking before making counts. A similar tendency to concentrate, but on a larger scale, may be expected in nature. Counts of a sample from such a concentration would be high. Ketchum (*5*) considered a tendency of the organism to concentrate as a possible cause of high surface organic phosphorus concentrations.

Mass cultures of *G. brevis* maintained in this laboratory are toxic to fish. We conducted toxicity experiments using *Mollienesia sp.* and *Mambras vagrans* as test fish. Controls consisted of water taken at the collecting point of the fish and unialgal cultures of *G. splendens* containing more than 2.5 million cells per liter. All fish died in the water containing *G. brevis*, but none died in either of the controls. This experiment was repeated with the same results (*18*).

References and Notes

1. C. Davis, *Botan. Gaz.* **109**, 358 (1948).
2. G. Gunter *et al. Ecol. Monographs* **18**, 309 (1948).
3. P. Galtsoff, *U.S. Fish Wildlife Service, Spec. Sci. Rpt. No. 46* (1948).
4. G. Gunter, F. Smith, and R. Williams, *Science* **105**, 256 (1947).
5. B. Ketchum and J. Keen, *J. Marine Research (Sears Foundation)* **7**, (1) (1948).
6. P. Galtsoff, *Sci. Monthly* **68**, 108 (1949); J. King, *Quart. J. Florida Acad. Sci.* **12** (2) (1949); H. Graham, J. Amison, and K. Marvin, *U.S. Fish Wildlife Service, Spec. Sci. Rpt., Fisheries No. 122* (1954).
7. A. Collier, *Science* **118**, 329 (1953).
8. L. Slobodkin, *J. Marine Research (Sears Foundation)* **12** (1) (1953).
9. C. Van Niel, *Archiv Mikrobiol.* **3**, 1 (1931).
10. S. Hutner and L. Provasoli, *Biochemistry and Physiology of Protozoa*, A. Lwoff, Ed. (Academic Press, New York, 1951), pp. 27–128.
11. L. Provasoli and I. Pintner, *Ann. N.Y. Acad. Sci.* **56**, 839 (1953).
12. B. Sweeney, *Am. J. Botany*, **41**, 821 (1954).
13. Haskins Laboratories, New York, personal communication.
14. B. Mason, *Principles of Geochemistry* (Wiley, New York, (1953), pp. 164–177.
15. A. Agassiz, *Bull. Museum Comp. Zool. Harv.* 16 (1890).
16. J. Webb, *Bull. U.S. Fishery Commission* 6 (1886).
17. F. Robinson, *The Vitamin B. Complex* (Wiley, New York, 1951).

18. Our grateful acknowledgment is due Luigi Provasoli and S. H. Hutner of the Haskins Laboratories, New York, for their unqualified assistance in connection with this research. Our thanks are also due B. Sweeney, Scripps Institute of Oceanography, and Theodore M. Rice, U.S. Fish and Wildlife Service Laboratory, Beaufort, N.C., for their kind assistance.

20 December 1954.

Visual Detection of Temperature-Density Discontinuities in Water by Diving

Conrad Limbaugh and Andreas B. Rechnitzer

Scripps Institution of Oceanography, La Jolla, California

Direct visual oceanographic observations of subsurface physical phenomena, formerly probed only by instrumentation, have gained impetus and have attained a much higher level of significance since the advent of such self-contained diving equipment as the Aqua-lung. Representatives of many of the scientific disciplines who participate in the study of the oceans have found a variety of uses for this direct method of observation, sampling, and measurement. Extensive free-diving research activities are carried on throughout the year at the Scripps Institution of Oceanography. The observation potential of the diving method of detecting, delimiting, and describing the temperature and other physical characters of water masses is, we hope, exemplified by the findings recorded here (*1*).

In certain areas, including places where the use of the bathythermograph (*2*) is difficult or inconvenient and where the water-mass pattern is on such fine scale that ordinary bathythermograph lowerings would likely miss important features, the thermocline and other phenomena can be detected visually and sensually by divers. Investigations of more oceanic waters by diving has been limited, but some information about the interfaces at thermoclines there has also been obtained (*3*).

Visual detection of the thermocline (or thermoclines) and of water-mass differences have been achieved in several ways: (i) indirectly by observing the vertical distribution of living organisms and other suspended particles, (ii) by viewing the refractory plane at the temperature-density discontinuity, and (iii) by the "stream" lines (refraction patterns) formed during the mixing of water masses of different density.

Frequently, plankton and leptopel (*4*) accumulate, so that they are readily visible at the temperature-density interface, where they are detained either above or below the discontinuity by the difference in water density. The groups of macroscopic animals

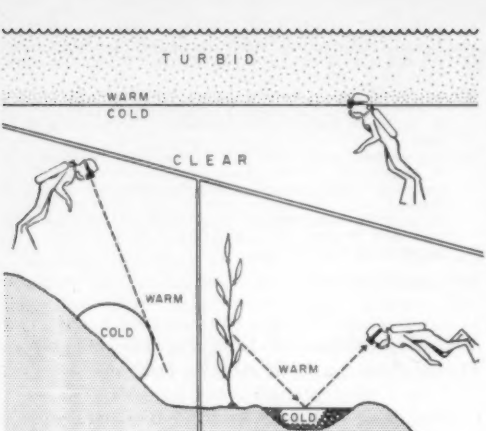


Fig. 1. Schematic representation of three temperature-density discontinuities observed by diving, with a bathythermogram appropriate for each of the temperature changes across the discontinuity.

that very frequently accompany such aggregations may be the only visible indications of a poorly defined thermocline. Patches of "red-water" resulting from blooms of *Gymnodinium* or *Prorocentrum* increase the turbidity of the surface layer, rendering it muddy and reducing visibility. The change to normally clear water below the turbid canopy at the thermocline, sometimes dramatically abrupt, clearly defines the location of the discontinuity. The concentrations of organic matter are most easily ascertained when the interface is near eye level (Fig. 1). Diving observations made in conjunction with simultaneous fathometer recordings of a diffuse near-surface reflection source have shown a definite agreement between the movements of the thermocline and of the associated living organisms and leptopel concentrations.

Difference in density between two water masses have been seen by us: (i) as a smooth, flat refractive plane of demarcation between two undisturbed water masses, and (ii) as an irregular boundary between two unstable masses undergoing mixing. The interface between two relatively quiescent masses of water is nearly parallel to the surface. Such a thermocline is best viewed by looking directly along the interfacial plane. Certain conditions, however, permit a greater angle of detection. A striking observation was made during the fall of 1953, at a time when the surface was calm and the water was clear. In the small tributaries at the head of the Scripps Submarine Canyon, at a depth of 100 ft, there are many small depressions containing trapped plant detritus. Among these accumulations of decaying vegetation were open areas with "pools" of turbid water, free of large pieces of matter. The upper surface of these clear areas in the depressions had a refractive-index differential great enough to reflect a mirror image of some kelp, *Macrocystis pyrifera*, which extended well above the surface of the depression (Fig., lower right). The entrapped water mass was only a few inches thick and, when probed by hand, was found to be markedly colder than the water above it. Other "mirror" pools were found in the vicinity, and all probably represented remaining portions of a cold water mass that had recently left the area. These pools are evidently transient phenomena, since they have seldom been observed.

On 19 September 1954, another interfacial discontinuity was seen near Avalon Harbor, Catalina Island. We descended to the steep sloping bottom at a depth of 60 ft without encountering a thermocline. Swimming along the bottom, however, we encountered an upwardly convex tongue of dense water 4 ft high and 10 ft wide, flowing parallel to the beach. The interface was well defined and easily discerned at any tangent across its surface. A sharp thermal gradient was noted as we penetrated the tongue, which exhibited refractive lines or patterns comparable to the mixing of two miscible liquids of unlike densities.

Unfortunately most of our underwater encounters with well-defined thermoclines and density discontinuities have been made without mechanical instruments or sampling devices, other than a depth gage, and were incidental to other objectives. The amount of oceanographic information available to the human sense is so great that each dive may reveal an enigma that can be only casually noted if the primary purpose of the dive is to be attained. As the utilization of self-contained diving apparatus in oceanographic research continues to expand, many contributions of value will undoubtedly be made, not only through simple observation but also through observation supplemented by the use of instruments and collecting gear carried by the diver. In particular, but not exclusively, we may hope for a more thorough understanding of the rapidly changing, relatively small-scale processes that characterize near-shore waters and are receiving an increasing share of attention from oceanographers.

References and Notes

1. Contribution of the Scripps Institution of Oceanography, New Series No. 764.
2. H. U. Sverdrup, M. W. Johnson, and R. H. Fleming, *The Oceans* (Prentice-Hall, New York, 1942).
3. E. C. LaFond, *Sci. Monthly* **78**, 243 (1954).
4. D. L. Fox, J. D. Isaacs, and E. F. Corcoran, *J. Marine Research* (*Sears Foundation*) **11**, No. 1, 29 (1952).

7 January 1955.

On Some Aspects of Spatial Pattern in Biological Populations

Philip J. Clark and Francis C. Evans

Institute of Human Biology, University of Michigan, Ann Arbor

The spatial pattern of distribution of the individual members of a population of organisms is obviously of importance in the analysis of population behavior. A knowledge of this pattern and of the forces responsible for it finds practical application, for example, in estimating the rate of spread of genetic mutations or in predicting the course of an epidemic. Such problems have attracted the interest of biometricians, and in recent years there have been numerous contributions to the statistical theory of distribution.

Recently, some attention has been given to the possibility of using distance between individuals as a variable in distribution analysis. Of the many distance relationships that exist, the most easily ascertained and the most amenable to mathematical treatment is the distance to nearest neighbor. Dice (*1*), Skellam (*2*), Moore (*3*), and Clark and Evans (*4*) have all made use of the distance to nearest neighbor in the study of spacing. Further reflection suggests that the nearest neighbor relationships in a population may in themselves reveal information about the distribution pattern that does not require measurement of the actual distances involved.

In natural populations, many individuals are spatially related to one another in a "reflexive" manner; that is, in many cases two individuals are closer to each other than either one is to any other individual. When the distance between two such individuals is small compared with distances to other individuals, there is an obvious occurrence of pairs, but in many situations this pairing tendency is much less readily apparent. It can be shown, however, that in a randomly distributed population the relation of nearest neighbor is reflexive for a definite proportion of individuals. Consider two individuals, I_1 and I_2, in a population of density ρ distributed at random in two-dimensional space, and let the distance between them be denoted by r. Then I_1 and I_2 may be regarded as the centers of two intersecting circles of radius r, to be designated as circle 1 and circle 2, respectively. The probability that I_2 is the nearest neighbor of I_1 involves the assumption that circle 1 contains no other individuals; this probability can be shown to be

$$dP = 2\pi r \rho e^{-\pi r^2 \rho} dr$$

Then, given the event that I_2 is the nearest neighbor of I_1, the probability that I_1 is also the nearest neighbor of I_2 is the probability that the portion of circle 2 not included in circle 1 contains no other individuals; this probability is

$$e^{-r^2 \rho (2\pi/3 + \sqrt{3}/2)}$$

Now the probability that I_1 and I_2 are the nearest neighbors of each other is the product of the two probabilities just given. By taking the integral from $r = 0$ to $r = \infty$ of this joint probability, we find the proportion P of the population for which the relation of nearest neighbor is reflexive to be

$$P = \frac{6\pi}{8\pi + 3^{3/2}} = 0.6215$$

This expected proportion of reflexives has been verified empirically in a synthetically constructed random population of 1000 points (Table 1). The number of individuals for which the relation of nearest neighbor is reflexive was found to be 602 in this population, and the difference between this and expectation is not statistically significant.

It may also be observed that the individuals of a population differ with respect to the number of other individuals for which they serve as the nearest neighbor. Some members of a population may be so placed that they are not the nearest neighbors of any other individual. Others, however, may serve as nearest neighbor to several individuals. In a random population of infinite size, the proportions of individuals that are nearest neighbors to 0, 1, 2, or more other individuals form a definite distribution that is independent of the population density. We have not succeeded in deducing the probabilities for these proportions, but approximations to them were obtained empirically from the synthetic random population mentioned previously (Table 1). Nearly 30 percent of the points did not serve as nearest neighbor to any other point, and approximately 70 percent were nearest neighbors to 1, 2, or 3 other points. The probability of serving as nearest neighbor to 4 or more

Table 1. Proportions of reflexive distances to nearest neighbor and of individuals serving as nearest neighbor to 0, 1, 2, and 3 other individuals in various populations.

Nature of population	No. of individuals in population	Proportion of nearest neighbor relations that are reflexive	Proportion of individuals serving as nearest neighbor to				
			0	1	2	3	4 or more
Synthetic random	1000	0.602	0.297	0.453	0.225	0.025	0.000
Liatris aspera	197	.579	.289	.467	.208	.036	.000
Lespedeza capitata	184	.609	.315	.435	.201	.049	.000
Solidago rigida	89	.607	.315	.416	.258	.011	.000

individuals is evidently extremely small. It can be shown to be impossible for any individual to be nearest neighbor for more than 5 other individuals.

These proportions of nearest neighbor relationships prove not to be restricted to random distributions. They may also occur in populations marked by a considerable degree of aggregation or clumping. For example, as is shown in Table 1, similar proportions were found to exist in populations of the plants *Liatris aspera* Michx., *Lespedeza capitata* Michx., and *Solidago rigida* L. occurring in an old field on the E. S. George Reserve, Pinckney, Mich. All of these have been shown to exhibit marked clumping tendencies (*4*). It is evident, therefore, that these nearest neighbor relationships are not affected by all types of departure from randomness. The distributional forces responsible for the aggregation in these plant populations seem not to have influenced their nearest neighbor properties. The most important factors in their distribution appeared to be the patchiness of environmental conditions and the particular methods of reproduction and dispersal of each species.

It is clear, however, that the nearest neighbor properties of populations will respond readily to social forces affecting distribution. Any social force that promotes the formation of pairs or of other relatively small groups will tend to increase not only the proportion of reflexive relationships but also the proportion of individuals that serve as nearest neighbor to 1 or more other individuals. When these proportions are greater than expected, one can conclude that in some way the individuals have responded positively to one another.

These observations suggest a way of separating the consequences of social forces from other factors affecting the spatial patterns of distribution in biological populations.

References

1. L. R. Dice, *Contrib. Lab. Vertebrate Biol., Univ. of Michigan* **55**, 1 (1952).
2. J. G. Skellam, *Biometrika* **39**, 346 (1952).
3. P. G. Moore, *Ecology* **35**, 222 (1954).
4. P. J. Clark and F. C. Evans, *ibid.*, 445 (1954).

22 November 1954.

Direct Recording from the A-V Conducting System in the Dog and Monkey

Allen M. Scher

Department of Physiology and Biophysics, University of Washington School of Medicine, Seattle

The functional properties of the cardiac purkinje tissue, like those of many anatomical entities, are known mainly from deduction and indirect methods. Older physiologists recognized that there is a delay between auricular and ventricular activity, and also that a bridge of special tissue connects these two divisions of the heart. They rightly concluded that the electric impulse is confined within this tissue during at least part of the delay. Lewis (*1*) in his work on the excitation of the heart correlated the peripheral distribution of the purkinje fibers in the ventricle with his findings relative to the sequence of cardiac excitation. Further, he and others found that cutting peripheral ramifications of the conducting system or destroying the A-V node caused changes in excitation. Recently Draper and Weidemann (*2*), using intracellular microelectrodes, have given an excellent picture of the electric characteristics of the portions of the conducting system that may be easily removed and studied, the false tendons. However, direct study of the tissue in the intact heart, particularly of the portions buried in the interauricular and interventricular septa, has not previously been available.

Fig. 1. Electric activity in conducting bundle of dog. (*A*) Records from electrode high in mid-interventricular septum under valve ring. Potential in center is from the bundle; slower potential changes at right show negative (receding) followed by positive (approaching) activity resulting from activation of ventricular myocardium. (*B*) Simultaneous Lead II ECG. P wave appears at left and QRS complex at right. It can be seen that biphasic bundle potential occurs about midway between auricular and ventricular activity. (*C*) Same potential as *A*, but faster sweep speed. Time pips were delivered simultaneously to both channels at 5-msec intervals. Bundle potential on *A* and *C* has peak-to-peak value of 3 mv.

During a continuing study of the pathway of normal ventricular activation, we had often taken records of excitation of the false tendons which cross the ventricular cavities, and it seemed possible to record from portions of the conduction system nearer to the A-V node and from the node iself.

Available apparatus consisted of a multichannel oscilloscope and multipolar needle electrode. These and the associated techniques have been described (*3*, *4*). The multichannel apparatus facilitated scanning of many loci in a search for potentials. In the open-chested dog, exploring electrodes were inserted into the interauricular septum anterior to the coronary sinus in the area where Tawara (*5*) has located the A-V node. Other electrodes were pushed into the interauricular and interventricular septa along the pathway of the conducting bundle and its branches and into the apical ventricular cavity where preter-

minal branches of the conduction system constitute the false tendons. These procedures have been successful in four dogs and one monkey.

The potentials from the region of the A-V node proper require a detailed and critical study, which is not within the compass of the present paper. They have varied markedly in certain respects. At times an electrode in this region records a local auricular depolarization followed by nodal depolarization, but at other times the former is lacking. Moreover, the records thus far do not permit any statement regarding the nature of A-V nodal delay or the mechanism of activation of the node.

An electrode a few millimeters from the A-V node records a small potential, usually biphasic, of about 2-msec duration and 5-mv amplitude (Fig. 1). This potential appears about 10 msec after the last sign of auricular activity and precedes the earliest sign of ventricular activity by about 40 msec. The potentials from the intraventricular false tendons containing the preterminal branches of the conduction system have similar characteristics, but precede earliest myocardial ventricular activity by only a few milliseconds (Fig. 2). If the direct distance between electrodes near the node and the false tendon is divided by the time required for impulse transmission, the calculated conduction velocity falls between 1.4 m and 1.7 m/sec. Since the impulse does not follow a straight path, the actual velocity must be greater. Thus, it appears that the conduction rate in the more central part of the system is nearer the 2.0 m/sec rate calculated for transmission in the false tendon (*2*) than the 1.0 m/sec found (*4, 6*) in the lining of most of the ventricular wall. When this system is stimulated in either a forward or a retrograde direction, the transmission time is identical to that during the spontaneous beat. There is no appreciable delay between activation of the terminal portions of the conducting system and activation of the ventricular musculature.

This work (*7*) is being continued with the hope that the difficult problem of the nature of A-V nodal delay and excitation will ultimately be understood.

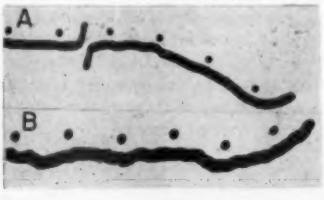


Fig. 2. Activity in false tendon of monkey. (*A*) Records from electrode that pierced false tendon in lower left ventricular cavity. Biphasic potential at left is from false tendon. Negative potential at right is caused by activity proceeding away from left cavity. (*B*) Simultaneous Lead II ECG. Time pips 5 msec. Biphasic potential on *A* has peak-to-peak value of 8 mv; it is followed in 7.5 msec by negative cavity deflection on that channel. ECG on *B*, 2.5 msec later, shows negative (Q) deflection followed by positive deflection.

References and Notes

1. T. Lewis and M. A. Rothschild, *Phil. Trans. Roy. Soc. B* **206**, 181 (1915).
2. M. H. Draper and S. Weidenmann, *J. Physiol.* (*London*) **115**, 75 (1951).
3. A. M. Scher *et al.*, *Circulation Res.* **1**, 539 (1953).
4. A. M. Scher *et al.*, *ibid.* **3**, 56 (1955).
5. S. Tawara. *Das Reizleitungssystem des Säugetierherzens* (Gustav Fischer, Jena, 1906).
6. This velocity is found with stimulation. Normally the endocardium is excited at many points simultaneously by the branched purkinje system. Thus, the apparent velocity is high.

7. Aided by a grant from the Washington State Fund for Biology and Medicine, and by a grant, H-1315, from the National Heart Institute.

22 November 1954.

Dosage Effect of Multiple *Dt* Loci on Mutation of *a* in the Maize Endosperm

M. G. Nuffer

Department of Field Crops, University of Missouri, Columbia

The mutability of certain alleles at the *A* locus on chromosome 3 in maize is affected to a remarkable degree by the gene *Dt* located on chromosome 9 (*1*). The mutations produced are changes of *a* to *A* that can be expressed, when the appropriate complementary genes are present, as long, slender, purple sectors of (*Aa*) cells surrounded by otherwise green or brown (*aa*) plant tissue and as frequent small purple or red (*Aaa*) dots on the colorless (*aaa*) aleurone of the seed.

In an effort (*2*) to find other genes similar to *Dt*, 98 strains of maize from Central and South America were tested. Included were 1 from Argentina, 5 from Bolivia, 6 from Brazil, 17 from Colombia, 2 from Costa Rica, 11 from Ecuador, 4 from Guatemala, 7 from Honduras, 4 from Mexico, 7 from Nicaragua, 31 from Peru, and 3 from Venezuela. The test consisted of backcrossing *Aa* heterozygotes, to an a^m *dt* tester and examining the ears produced for colorless seeds with red or purple dots (reversions). The a^m allele in the stock used is extremely sensitive to the action of *Dt* (*3*), and therefore it provides an excellent indicator of the presence of possible weak expressions of *Dt*. Two of the races tested gave positive dotting: a Brazilian yellow flint variety called Cateto and a purple aleurone race from the Peruvian coastal village of Huarmey.

A number of investigations were made for the purpose of locating and characterizing these two possible *Dt* genes. Tests for their allelism with Dt_1 and with each other showed that they are independent loci. They were, therefore, designated Dt_2 (from Brazil) and Dt_3 (from Peru). Preliminary linkage data from the original backcross indicate that Dt_2 is linked to *Y* (*Y* produces yellow endosperm and *y* white) on chromosome 6 with 26-percent recombination. Linkage data are not yet available for Dt_3. An effort was made, using the x-ray induced deficiency method (*4*), to confirm the location of Dt_2 and to place both Dt_2

and Dt_3 in their proper positions on the chromosome map. Two plants, one deficient for Dt_2 and the other for Dt_3, were obtained. Cytological examination revealed that the first had lost all the long arm of chromosome 6, except for the three heavy-staining proximal chromomeres, and that the second was deficient for the terminal end of the long arm of chromosome 7, including all the material beyond the heterochromatic knob that commonly occurs on this chromosome.

From the afore-mentioned facts it can be reasoned that, since Dt_2 is included in a deficiency of the long arm of chromosome 6 and is linked with 26-percent recombination to *Y* (*Y* is located very near the centromere), it must be approximately 26 crossover units distal to *Y* or near the gene *Pl*. Comparable data are not available for an accurate placement of Dt_3.

The behavior of both Dt_2 and Dt_3 is similar to Dt_1 in that all three cause *a* and a^m to mutate at comparable frequencies and in a fashion characteristic of the *a* allele involved. Similarly, there is an exponential increase in response to each when their respective dosages are increased from one to three in the endosperm.

A preliminary comparison of Dt_1 and Dt_2 was made using the offspring from the cross of *aa*, Dt_2 Y/dt_2 *y*, Dt_1 dt_1 by homozygous *a*, dt_2 *y*, dt_1. Ears were obtained that had seeds of the noncrossover classes; yellow Dt_2 (two doses), yellow Dt_2 Dt_1 (four doses), white Dt_1 (two doses), and white nondotted plus the recombination classes white Dt_2, white Dt_2 Dt_1, yellow Dt_1 and yellow nondotted. The four-dose seeds have 10 times as many reversions as the two-dose seeds of either the Dt_2 or the Dt_1 types, thus allowing identification of the two-dose class.

Even though crossing over between Dt_2 and *Y* is high, sizable differences in dotting frequency and character between Dt_1 and Dt_2 should be demonstrated in a comparison of the two-dose yellow seeds with the two-dose white ones. Reversion counts of 53 seeds revealed that the average dot number for yellow seeds was 6.04 ± 3.5 and for the white seeds was 5.73 ± 3.4. Such a slight variation in dot number coupled with an apparent lack of differences in the character of the reversions observed on these sib seeds provide some justification for considering Dt_1 and Dt_2 as equivalent, and for attributing the differences in dot number among the three unrelated *Dt* cultures listed in Fig. 1 to genetic modifiers.

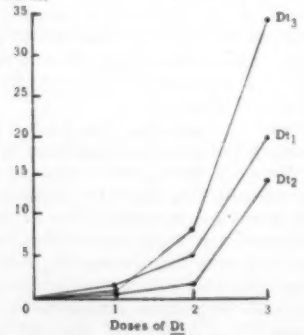


Fig. 1. The effect of one to three doses of Dt_1, Dt_2 and Dt_3 from selfed *aa Dt Dt* ears.

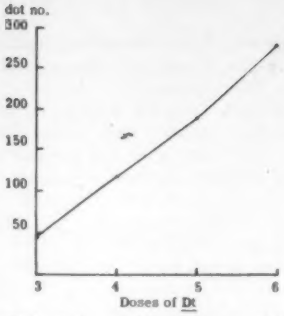


Fig. 2. The effect of the combined dosage of Dt_1 and Dt_2 on dot frequency.

Since Dt_1, Dt_2 and Dt_3 have similar dosage relationships, experiments dealing with their combination for higher doses have distinct possibilities. It should be possible in the 3N maize endosperm to get up to nine doses of *Dt* with these genes. At present only the data from the addition of Dt_1 and Dt_2 are available. Seeds with three, four, five, and six doses of *Dt* were obtained from the cross of *aa*, Dt_2 Y/dt_2 *y*, Dt_1 Dt_1 by *aa*, Dt_2 y/dt_2 *y*, Dt_1 Dt_1. These dots on each seed were counted, the seeds were sorted for *Y* and *y*, and adjustments for crossing over were made.

As can be seen by the data presented in Fig. 2, the frequency of dotting increases with increasing *Dt* dosage up to six doses, even though it is not clear whether the curve is an exponential one, a linear one, or one represented by the part of a sigmoid curve that lies near the point of inflection. Data from the addition of Dt_3, which will permit the study of seven, eight, and nine doses of *Dt*, should extend the curve to a point that will indicate which type of curve we have.

Significantly, the character of the reversions produced does not change when their frequency is altered. The dots at all dosage levels have the same size, shape, and color intensity. This is quite different from the behavior of other mutable loci-mutator combinations, such as McClintock's Ds-Ac system (*5*) and the bz-M system (*6*), in which changes in dosage of the mutator not only cause a change in frequency but also in size of the sectors produced.

References and Notes

1. M. M. Rhoades, *Genetics* **23**, 237 (1938).
2. This work was supported by a grant from the U.S. Atomic Energy Commission, contract AT(11-1)–73, project No. 4. This paper is Journal Series Paper No. 1493 approved by the director of the Missouri Agricultural Experiment Station.
3. M. G. Nuffer, *Maize Genetics Coop. News Letter* **25**, 38 (1951).
4. ———, *ibid.* **28**, 64 (1954).
5. B. McClintock, *Cold Spring Harbor Symposia Quant. Biol.* **16**, 13 (1951).
6. M. G. Nuffer, *Maize Genetics Coop. News Letter* **28**, 63 (1954).

6 December 1954.

Communications

Effect of Arasan-Treated Corn on Laying Hens

During the summer of 1954 a diseaselike condition occurred on at least six farms in Minnesota involving approximately 75,000 hens. Most of these were located on a large breeding farm (*1*), the owner of which appealed to the University of Minnesota animal diagnostic laboratory for assistance.

Birds in full egg production stopped laying normal eggs. Subsequently many soft-shelled eggs were found under the roosts. Most of the few hard-shelled eggs were misshapen. A similar pattern occurs when hens are afflicted with Newcastle disease, infectious bronchitis, or pullet disease, but an attempt to isolate an infectious agent was unsuccessful.

After 2 wk the birds returned toward normal production. However, the same egg-production disturbance soon reappeared. Hens laying 500 eggs daily per 700-bird pen produced 20 to 30 abnormally shaped eggs plus many soft-shelled eggs. With recurrence, the possibility of disease was virtually ruled out, since acute diseases usually impart an immunity to recovered birds.

A home-mixed ration was used on this farm. During the second outbreak, a few of the many pens were changed to a commercial ration. Egg production improved rapidly in these pens. Thus, feed was implicated with the disturbance.

Therefore, an on-the-farm experiment was conducted in which various ingredients were omitted from the normal diet to determine whether a single feed ingredient was responsible. The result indicated that corn was causing the difficulty.

Experiments were then conducted in the university poultry department in which various seed treatments were tested in hen diets. Arasan-SFX had a very pronounced depressing effect on egg production, similar to that produced by the toxic farm rations.

A further experiment (Table 1) compared the performance of a group of hens receiving an implicated farm ration (field ration A) with that of groups receiving Arasan additions to normal diets (*2*). This experiment was performed in batteries with wire-mesh floors to permit daily observation of soft-shelled eggs. The hens receiving field ration A showed only a mild egg-production depression and produced but few soft-shelled eggs. About one-half of the eggs produced were abnormally shaped. This result was similar to that of the group receiving 50 parts per million (ppm) of Arasan; however, egg production was more severely affected by the 50-ppm Arasan diet. Hens receiving 100 to 200 ppm of Arasan ceased laying normal eggs immediately and began producing soft-shelled eggs. In an attempt to show this latter behavior with an implicated farm ration, additional hens were added to the experiment and were fed field ration B. The behavior of this group paralleled that of the group receiving 100 ppm of Arasan.

The various rations used in this experiment were analyzed chemically for tetramethylthiuram disulfide (TMTD), the active fungicidal ingredient of Arasan. Field rations A and B contained the equivalent of about 22 and 104 ppm of Arasan, respectively. Thus the result of the chemical analysis confirmed the biological response presented in Table 1.

Since the Arasan product used in this investigation contained 25 percent of inert ingredients, it was important to determine whether the active fungicidal ingredient also caused the egg-production disturbance. Therefore, a practical grade of TMTD was recrystallized and tested; TMTD was found to be entirely responsible for the effect of Arasan.

The mode of action of TMTD in the metabolism of the hen is obscure. The shell-less eggs are laid at night. This suggests premature expulsion of the egg from the uterus, where the hard shell is normally deposited. Experiments designed to elucidate the metabolic disturbance are in progress.

The tetra*alkyl*thiuram disulfide series of compounds has a wide variety of uses. The methyl derivative is employed as a seed and turf fungicide and is also used widely as an accelerator in the vulcanization process of rubber manufacture. The ethyl derivative is the active component of Antabuse, employed in the treatment of chronic alcoholism in man. The tetra-

Table 1. Effect of Arasan-SFX and implicated farm rations on egg production. Each number without parenthesis represents the number of hard-shelled eggs laid by eight S.C. White Leghorn hens during a 4-day period; each number in parenthesis represents the number of soft-shelled eggs laid during the same period.

Diet	Preexperimental 4 days	Days of experimental period			
		1–4	5–8	9–12	13–16
Control	27	27 (0)	27 (0)	26 (0)	25 (0)
Control plus 10 ppm Arasan	25	27 (0)	22 (2)	22 (1)	23 (1)
Control plus 50 ppm Arasan	23	24 (1)	18 (1)	12 (3)	7 (3)
Control plus 100 ppm Arasan	28	17 (5)	1 (11)	1 (6)	1 (6)
Control plus 200 ppm Arasan	23	8 (16)	0 (11)	0 (12)	0 (6)
Field ration A	24	20 (3)	16 (2)	11 (1)	15 (1)
Field ration B*		15 (9)	1 (8)		

* Field ration B was tested 8 days later than were the other diets. All birds were in good production as judged by previous trap-nest records.

methyl compound is more toxic than the tetraethyl compound for laboratory rats.

A recent report (*3*) dealing with the use of Arasan-DDT-treated seed corn (simultaneous with an epsom-salt flush) in a small farm flock of hens has come to our attention. Egg production was observed to decrease rapidly. However, no conclusions were drawn regarding the causative agent. We are aware of no other published information related to the extreme toxicity of Arasan for hens (*4*).

A sample of corn meal obtained from a farm severely affected during these outbreaks contained 470 ppm of TMTD. Fully treated seed corn contains about 630 ppm of TMTD. The corn meal in field rations A and B contained about 35 and 160 ppm of TMTD, respectively. Thus Arasan-treated seed corn could be diluted heavily with nontreated corn and still produce disastrous results. The label on the container of Arasan-SFX used in this study stated: "The use of this seed for food, feed, or oil purposes is not recommended" (*5*).

Because of the hen's rapid reproductive rate (200 to 300 eggs per year), ease of maintenance, and sensitive reproductive mechanism, it would seem to be an ideal subject for toxicologic studies. Certainly, routine growth studies leave much to be desired in the evaluation of potentially toxic substances.

P. E. WAIBEL
B. S. POMEROY
ELTON L. JOHNSON
Departments of Poultry Husbandry and Veterinary Science, University of Minnesota, St. Paul

References and Notes

1. Ghostley Poultry Farm, Anoka, Minn.
2. The percentage composition of the experimental diet was as follows: ground yellow corn 50, wheat bran 10, wheat middlings 10, alfalfa meal 5, meat and bone scraps 7.5, fish meal 2.5, soybean meal 10, bonemeal 3.0, ground limestone 0.75, iodized salt 1.0, feeding oil (300 D-2250 A) 0.6, and $MnSO_4$ 0.025. The following were added per kilogram; riboflavin 2.75 mg and vitamin B_{12} 3.3 μg. Oyster shell was supplied *ad libitum* for all birds.
3. G. J. Cottier, *Auburn Veterinarian* **10**, 115 (1954).
4. This article is paper No. 3295, Scientific Journal Series, Minnesota Agricultural Experiment Station. We wish to express our appreciation to Norman E. Foster, chief chemist, Minneapolis District, Food and Drug Administration, for his cooperation during this study.
5. Arasan-SFX (Du Pont) contains 75 percent tetramethylthiuram disulfide, which is the active fungicidal ingredient in seed treatment.

31 January 1955.

An Application of Statistics

It is commonly stated that one can prove anything by statistics. The mere fact that two variables are significantly correlated by accepted statistical treatment of valid observations does not *ipso facto* prove that the correlation has any biological meaning. In searching for a phenomenon that would illustrate these truisms, I was struck by the fact that months with short names are generally, in the north temperate zone of the continental United States, the warm ones, and those with long names are the cold ones. The short-name months also tend to have more rainfall than the long-name months.

To test whether or not there was a statistically significant correlation between the length of the name of the month and the temperature and precipitation, meteorological data for Chicago, Illinois, were chosen. The data represented the mean monthly temperature and the mean monthly precipitation for that station; the source was *Annual Climatological Summary, 1947*. The statistical procedures employed were taken from F. E. Croxton [*Elementary Statistics with Applications in Medicine* (Prentice-Hall, New York, 1953)]. The regression equation that related the number of letters in the names of the months (Y) and the mean monthly temperature (T) was $Y = 8.46 - 0.047T$. The correlation coefficient was -0.448 ($P = 0.15$). This association was suggestive but not statistically significant. The regression equation that related the number of letters in the names of the months (Y) and the mean monthly precipitation (P) was $Y = 11.92 - 2.10P$. The correlation coefficient was -0.611 ($0.05 < P < 0.025$). This association was significant at the 5-percent level. These associations have proved to be useful teaching examples of what can be done by the application of statistics, for here are significant correlations without *a priori* or *a posteriori* bases.

FREDERICK SARGENT, II
Department of Physiology, University of Illinois, Urbana

10 January 1955.

Note on a Visible Thermocline

On the afternoon of 5 May 1954 I was exploring the reef off Vaiala, slightly more than ½ mi to the east of the harbor of Apia, Upolu, Western Samoa, in search of a good collecting site for the invertebrates I was studying [under a grant from the Bernice P. Bishop Museum in Honolulu]. I was wearing "skin-diving" equipment, a face plate and swim fins.

The day had been very hot and still, and the surface waters over the ½-mi broad fringing reef were extremely warm, actually hot to the body upon entrance. Moreover, this water was so turbid from suspended matter carried down from the hills in a recent storm that the underwater visibility was less than 3 or 4 ft. There was very weak surf on the reef front.

At the reef front I dived down to explore the bottom, about 30 ft deep. As I went down I was able to detect three layers in the water. The hot turbid layer was 4 or 5 ft deep and sharply delimited from the intermediate layer, which was moderately warm and quite clear. Below the intermediate layer, which extended down to about 15 ft, there was a markedly cooler and clearer layer extending to the bottom.

On the completion of my first dive to the bottom I "coasted" back up, allowing the buoyancy of my body to carry me slowly to the surface while I looked at

the reef. As I passed from the bottom layer to the intermediate layer I noticed a discrete horizontal line in the water, somewhat similar to the edge of a piece of glass. I wondered about this line and made a series of dives to investigate it. Diving down the motions of swimming caused so much agitation that the line was not visible, but by returning slowly to the surface through the undisturbed water the demarcation between the layers was visible each time. It could not be seen from more than 2 or 3 in. above or below the interface, and viewed horizontally it seemingly had no thickness but was merely a refractive plane.

Unfortunately in my field gear I had no equipment to measure salinity, temperature, or even depth, so I could not confirm my observations with any measurements. However, there can be only one way to account for the plane that I observed. It is well known that the refractive index of sea water increases with decreasing temperature and increasing salinity [H. U. Sverdrup, M. W. Johnson, and R. H. Fleming, *The Oceans* (Prentice-Hall, New York, 1946), p. 70]. These two masses of clear, still water certainly had different temperatures and probably different salinities. The plane seen was the result of the difference in their refractive indices and marked the location of a very sharp thermocline.

Although I have often seen a sharp demarcation between turbid water and clear water while diving, in my years of skin-diving in the Pacific I have never before seen this phenomenon. I have never heard it remarked upon by other divers, nor have I seen it reported in the literature.

ALBERT H. BANNER
Department of Zoology and Entomology, University of Hawaii, Honolulu

8 December 1954.

Prevention of Evaporation in Horizontal Strip Ionography

In a recent communication concerning electrophoresis in paper stabilized media, [*Science* **120**, 677 (1954)], Samuel Raymond has performed a useful service by focusing attention on the question of whether the current or the voltage ought to be held constant when one is determining mobilities. The answer to this question, which was previously considered in detail by Marbach (*1*), does not depend, under proper experimental conditions, on whether the paper strip is open to a gaseous atmosphere or is sandwiched between glass or plastic plates.

Raymond states, "When the paper is exposed to an atmosphere, whether saturated or not, evaporation from the paper occurs because of heat generated by the electric current." This statement is not necessarily true and may mislead some persons into thinking that the horizontal paper-strip technique, which is in wide current use, is unsuitable for mobility determinations. As has been pointed out (*2*), the addition of 5 to 15 percent glycerol, ethylene glycol, or other similar low-molecular-weight substances to the buffer solution, causes the vapor pressure of the solution saturating the paper strips to be lowered below that of the water in the space surrounding the buffer vessels. Since the enclosed air or helium gas space (which is kept minimal by the addition of the maximum allowable water to the chamber) is saturated with respect to pure water, the paper strips saturated with buffer solution containing glycerol can be maintained at a temperature above their surroundings without the occurrence of any net loss of water, owing to evaporation. The strength of the electric current carried by the strips can be varied empirically to a point where the escaping tendency of water molecules from the buffer-saturated strips is just equal to the escaping tendency of water molecules from the pure water in the chamber, and under these conditions, no net loss of water whatever occurs from the paper surface.

It is then possible to maintain a constant current and potential gradient for hours, and with such an arrangement the field strength is calculated directly by dividing the applied voltage by the length of paper measured between the surfaces of the buffer solution in the end vessels. Other things being equal, the lower the molecular weight of the addition compound, the greater the vapor pressure lowering achieved at a given weight concentration. The additives should not of course, in general, alter to any appreciable extent the electrochemical characteristics of the buffer solution, such as its conductivity, *p*H, ionic strength, dielectric constant, and so forth, and should not form complexes with either the migrant or the buffer. Other methods for determining meaningful mobilities using the horizontal paper-strip technique are considered in greater detail in a forthcoming monograph (*3*).

HUGH J. MCDONALD
Stritch School of Medicine and Graduate School, Loyola University, Chicago 12, Illinois

References

1. E. P. Marbach, Ph.D. dissertation, Loyola University (1954).
2. H. J. McDonald, *J. Chem. Educ.* **32**, 428 (1952).
3. ——— *et al., Ionography; Electrophoresis in Stabilized Media* (Year Book Pub., Chicago, in press).

1 December 1954.

Aside from its effects on viscosity, dielectric strength, and other factors that affect the electrophoretic mobility, the chief effect of glycerol in the buffer solution is to increase the temperature difference between the buffer and pure water at vapor equilibrium. A tenth-molar buffer is at vapor equilibrium with pure water when its temperature is approximately 0.1°C above the water temperature. This is increased 0.4°C in a 10-percent glycerol solution. If vapor equilibrium is maintained, this small temperature difference must account for all the cooling of the paper in hanging-strip apparatus. The permissible power dissipation in the paper is thereby severely limited.

Although measurements are complicated by concentration changes in the paper resulting from evaporation, condensation, or electroosmosis while equilibrium is being reached, preliminary experiments indicate that a power level of less than 0.001 w/cm² is permissible. This corresponds to a field strength of less than 3 v/cm. In practice it is difficult to determine the exact power level for equilibrium; and unless accurately standardized conditions and low voltages are used, the glycerol concentration will change during the run. At normal levels of operation in hanging-strip apparatus, most of the heat generated in the paper is carried away by evaporation, as I have stated; the addition of glycerol increases slightly the proportion of heat removed by other routes—that is, conduction, convection, and radiation.

These complications are completely avoided in the pressure-plate type of apparatus, where the vapor space is entirely eliminated and the paper is in good thermal contact with thermostatted cooling plates. For good results a constant pressure must be maintained on the paper; apparatus for doing this will be described in a separate publication.

Most workers in this field recognize that specific identifying tests applied to the completely separated fractions obtainable in paper electrophoresis make "absolute" mobility determinations unnecessary. Useful mobilities can be obtained by applying various empirical corrections.

I hope my note did not mislead anyone into thinking that horizontal paper-strip apparatus is unsuitable for electrophoresis work. Indeed, as the designer of such an apparatus, I prefer it to other types. I must add, however, that in my opinion the pressure plate is an essential element of the design.

SAMUEL RAYMOND

College of Physicians and Surgeons, Columbia University, New York 32, N.Y.

12 January 1955.

Lattice Constants of Pure and Fluoride-Contaminated Ice

X-ray measurements have been performed to obtain precise values for the unit cell dimensions of pure and fluoride-contaminated ice. A new c/a ratio is calculated for pure ice, and in the case of fluoride-contaminated ice evidence is found that this impurity enters into the ice structure substitutionally. The latter finding is important in connection with the mechanism of electric conductivity in fluoride-contaminated ice, since it has been shown that presence of traces of fluoride ions almost completely determines the electric conductivity (*1*, *2*).

The lattice constants of pure and fluoride-contaminated ice were determined by the use of a symmetrical back-reflection focusing camera designed specifically for use on ice. The diameter of the camera was 17 cm, and the area of the irradiated sample was 24 mm². Copper K_α radiation was used with an exposure time of 12 hr at 17 ma and 40 kv. The sample temperature during the time of exposure was -46.0 ± 0.7°C. The Miller indexes of the back-reflection lines were determined by the graphical method of Bjurström (*3*), and the procedures of calculation followed Jette and Foote (*4*).

The lattice constants of pure ice (prepared from water having a specific conductivity of 2.5×10^{-7} mho/cm at 20°C) were measured at -46°C giving the values: $a = 4.507_1 \pm 0.000_5$ A and $c = 7.332_7 \pm 0.000_9$ A. In the case of fluoride-contaminated ice (frozen from $4.5 \times 10^{-4}M$ CsF), the dimension of the cell base was found to be the same as that for pure ice, but the cell height was 0.033 ± 0.025 percent shorter. Since only the fluoride ion is incorporated (*1*) and considering the properties of this ion, one would expect a slight shortening of the lattice if the impurity enters substitutionally. On the other hand, the amount of fluoride used would be expected to produce a detectable expansion of the lattice if it were incorporated interstitially. The fact that the fluoride impurity did not *increase* the unit cell dimensions gives evidence that this impurity enters into the ice structure substitutionally rather than interstitially.

The afore-mentioned values for the lattice constants of pure ice agree fairly well with the values obtained by H. D. Megaw (*5*). The slight difference that does exist between Megaw's values and the values stated here for pure ice leads to a new value for the c/a ratio of 1.627 at -46°C as opposed to the ideal value of 1.633. The present determination of the c/a ratio for pure ice further substantiates Bjerrum's argument concerning preferred dipole orientation (*6*).

FRANK K. TRUBY

New Mexico Institute of Mining and Technology, Socorro, New Mexico

References

1. E. J. Workman and S. E. Reynolds, *Phys. Rev.* **78**, 254 (1950).
2. E. J. Workman, F. K. Truby, and W. Drost-Hansen, *ibid.* **94**, 1073 (1954).
3. T. Bjurström, *Z. Physik.* **69**, 346 (1931).
4. E. R. Jette and F. Foote, *J. Chem. Phys.* **3**, 605 (1935).
5. H. D. Megaw, *Nature* **134**, 900 (1934).
6. N Bjerrum, *Science* **115**, 385 (1952).

4 January 1955.

Think like a man of action and act like a man of thought.—HENRI BERGSON.

Announcing the

New (2nd) Edition of . . .

General Endocrinology

by C. Donnell Turner, Ph.D.

This outstanding endocrinology text approaches the subject from a truly biologic viewpoint. Now in a *New (2nd) Edition,* every chapter of the book has been thoroughly revised to include the most up-to-date concepts. New chapters include: The Principles of Endocrinology, Adaptive Reactions to Stress, and Endocrine-Like Mechanisms. More space has been devoted to neurosection, in keeping with the concept that neurosectory cells perform a liaison role, connecting the nervous and endocrine systems.

This *New (2nd) Edition* features more logical organization of subject matter. The biochemical sections have been extended and placed near the beginning of each chapter. The new order of topics is: anatomy, biochemistry, physiology and a general treatment of clinical applications.

New photographs illustrating typical endocrine disturbances in man and animals have been added.

By C. Donnell Turner, Ph.D., formerly Chairman of Department of Zoology, Utica College of Syracuse University. About 600 pages, 6" x 9", with about 170 illustrations.
New (2nd) Edition—Ready in May!

W. B. SAUNDERS COMPANY

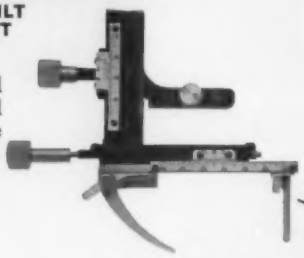
West Washington Square **Philadelphia 5**

UMECO

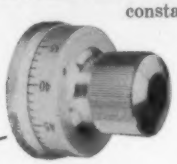
FULLY GUARANTEED

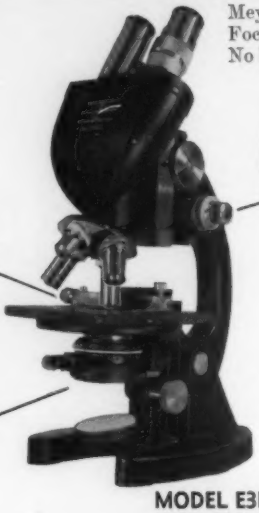
PRECISION BUILT THROUGHOUT

Graduated Mechanical Stage

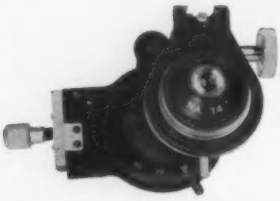


Meyer's Gear System Fine Focusing—Extreme Precision. No back-lash can occur despite constant use.





3-lens ABBE Condenser N.A. 1.4 with Research type Substage



$395.00

Includes Monocular Tube for photomicrography, all accessories, & carrying case.

MODEL E3N
50X-2250X
BINOCULAR MICROSCOPE

UMECO OPTICAL DIVISION
Dept. 2S, 465 California Street, San Francisco 4, Calif.

RESEARCH BIOCHEMICALS

OF

HIGHEST POSSIBLE PURITY

FOR INVESTIGATIONAL USES

"VITAMIN FREE" CASEIN
(Hot Alcohol Extracted)

A valuable source of protein nitrogen of exceptional purity for incorporation into diets to produce vitamin deficiencies.

MISCELLANEOUS BIOCHEMICALS

AMINO ACIDS

A complete selection of more than 100 amino acids.

"VITAMIN FREE" CASEIN HYDROLYSATE

Pre-tested for microbiological vitamin assays.

NUCLEOPROTEINS — PURINES PYRIMIDINES

A complete selection of all derivatives.

WRITE FOR NEW CATALOG
(February 1955)
OVER 1500 ITEMS

NBC

NUTRITIONAL BIOCHEMICALS CORPORATION

21010 MILES AVENUE • CLEVELAND 28, OHIO

FACTS ON INFRARED
FOR THE LABORATORY

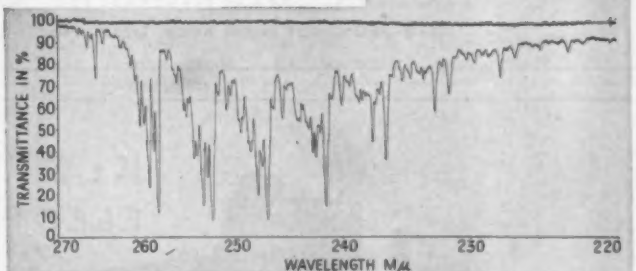
Complete Spectroscopy Lab In One Instrument

Transmittance Recording from the Ultraviolet to the Far Infrared

The Model 13-U Universal Spectrophotometer is the first instrument to provide complete coverage of the ultraviolet, visible, near-infrared, and fundamental infrared regions—from 205 millimicrons to 15.5 microns. An accessory prism extends the range to 37.5 microns.

Optimum performance is obtained throughout the entire range. The instrument features high speed scanning, excellent resolution and measurement precision. A wide variety of sampling accessories for solid, liquid and gaseous samples greatly extends the usefulness of the new spectrophotometer. A Model 13-U equipped with a microscope becomes a Microspectrophotometer—capable of recording spectra on single fibers, small crystals, etc.

Because of the versatility and flexibility of the Model 13-U, it can handle practically any analysis to which absorption spectroscopy techniques apply. Here, in one instrument, is all the analytical equipment needed to equip a first-rate spectroscopy laboratory.



High resolution run of benzene vapor spectrum made in the ultraviolet region on the Model 13-U with a 1 cm. path cell.

The Perkin-Elmer Corporation
840 Main Avenue, Norwalk, Conn.

☐ Please send me information on the Model 13-U.

☐ Please send me further information on other laboratory, process stream instruments of your manufacture.

NAME..... TITLE.....

COMPANY.....

ADDRESS.....

PERKIN ELMER—*FIRST IN ANALYTICAL CONTROL*

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D. C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of March 3, 1879. Annual subscriptions: $7.50; foreign postage, outside the Pan-American Union, $1; Canadian postage, 50¢.

THE BAKER INTERFERENCE MICROSCOPE

The Interference Microscope represents the very latest development in microscopical optics.

In monochromatic light the images obtained are similar to phase-contrast images, but with continuously variable phase-change adjustment and a considerably greater sensitivity. The optical artifacts associated with phase-contrast are noticeably absent, whilst in white light the images are seen in colour contrast. The instrument is both easy to set up and to adjust.

The microscope enables small phase-changes, under good conditions down to 1/300 wavelength, to be measured. From these phase-change measurements the dry-mass of cells and other microscopical bodies can be calculated and refractive indices determined.

The Interference Microscope, in either double-focus or shearing form, is now available for delivery.

THE BAKER IF MICROSCOPE OFFERS THESE UNIQUE FEATURES:

- Instant changeover from IF to normal illumination and return without re-adjustment
- Low and medium powers require no immersion
- Extremely high light transmission due to absence of reflecting surfaces
- Viewing of cell interiors thru system of localized coverglass compression, removes surface irregularities
- Binocular inclined body tube for greater convenience

C. A. Brinkmann & Co.,

378-380 Great Neck Road, Great Neck, L. I., N. Y.

KLETT ELECTROPHORESIS

CUSTOM MADE

TOOL FOR THE ANALYSIS
OF COMPLEX COLLOID SYSTEMS, AND FOR
THE CONTROL OF PRODUCTION OF
PURIFIED PROTEINS, ENZYMES, HORMONES

KLETT MANUFACTURING CO.
179 EAST 87TH STREET
NEW YORK, N. Y.

INTERNATIONAL Hemacrit

A *New* HIGH-SPEED MICRO-HEMATOCRIT CENTRIFUGE FOR CAPILLARY BLOOD TUBES

Rapidly increasing recognition of the time and labor saved by the improved Guest-Siler method for rapid, accurate, blood cell volume testing has prompted the introduction of the new International Hemacrit Centrifuge. The new technique involves four rapid steps: 1. Blood sample is taken directly from finger in a heparinized capillary tube. 2. Tube is sealed. 3. Sample is centrifuged 4 or 5 minutes at 11,000 r.p.m. 4. Per cent blood cell volume is read directly by means of a reader or microscope. Results are accurate, the test can be made quickly, only a micro quantity of blood is necessary, and the inexpensive micro-capillary tubes can be used once and discarded, eliminating the cleaning of expensive glassware. See "Journal of Laboratory and Clinical Medicine," Vol. 19, No. 7, April, 1934.

The International Hemacrit Centrifuge is designed specifically to spin 24 of the glass capillary blood tubes at speeds in excess of 11,000 r.p.m. Its many exclusive features make it the centrifuge of choice for this application.

SAFETY — The high-speed rotating head is completely enclosed, insuring protection to the operator.

ACCURACY — The 24 tube slots in the head are individually numbered for easy identification of blood samples.

CONVENIENCE — When the protective dome is opened, the head is completely exposed for ready accessibility. The unique design of the head permits easy removal of the glass tubes.

SPEED — The quiet, dependable universal motor is capable of maintaining a minimum of 11,000 r.p.m. on any 110 volt A.C. or D.C. circuit.

AUTOMATIC — A simple twist of the knob turns the centrifuge on and at the same time sets the running time. Centrifuge shuts off automatically.

BEARINGS — The motor has sealed bearings which are lifetime lubricated and require no attention.

STABILITY — The weighted base insures stability, and rubber suction feet eliminate creeping.

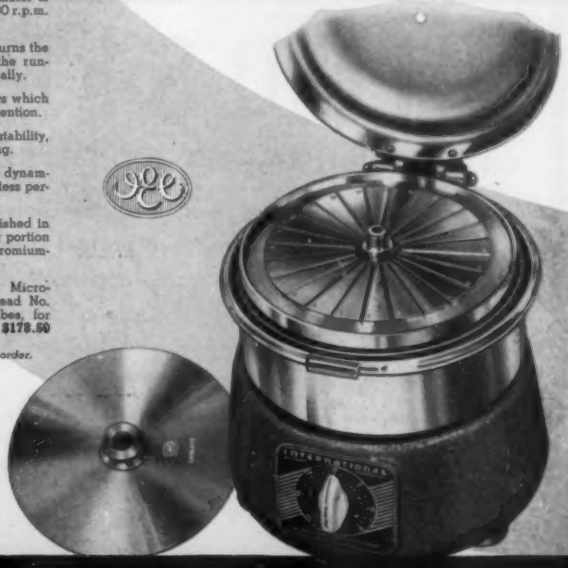
SMOOTH — The rotating head and cover are dynamically balanced to insure quiet, vibrationless performance.

ATTRACTIVE — The centrifuge base is finished in baked glossy gray enamel and the upper portion of the machine and cover is heavily chromium-plated.

400 International HEMACRIT 11,000 r.p.m. Micro-Hematocrit Centrifuge complete with head No. 275 for holding 24 capillary blood tubes, for 110-115 volts, A.C. or D.C. **$178.50**

Can also be furnished for 230 volts on special order.

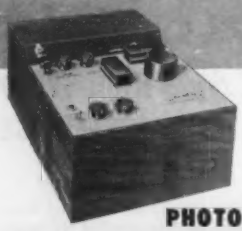
Prompt delivery from your Laboratory Apparatus Supply Dealer.



INTERNATIONAL EQUIPMENT COMPANY

1284 SOLDIERS FIELD ROAD, BOSTON 35, MASS.

FARRAND



PHOTOELECTRIC

FLUOROMETER

For All Fluorochemical Methods of Analysis

An instrument of high sensitivity for measurement of extremely low concentrations in micro or macro volumes.

A list of users, technical references and a descriptive bulletin No. 803 gladly sent upon request.

- ENGINEERING
- RESEARCH
- DEVELOPMENT
- DESIGN and MANUFACTURE of PRECISION OPTICS ELECTRONICS and SCIENTIFIC INSTRUMENTS

FARRAND OPTICAL CO., Inc.
BRONX BLVD. & EAST 238th STREET
NEW YORK 70, NEW YORK

Now available . . .

ACETONE POWDERS OF:
PIGEON BREAST MUSCLE
PIG HEART
PIGEON LIVER

Suitable for Coenzyme Assay

BOVINE HEMOGLOBIN SUBSTRATE

For proteolytic activity assay

WORTHINGTON BIOCHEMICAL CORPORATION
FREEHOLD, NEW JERSEY

INOSITOL

...A SIGNIFICANT NUTRITIONAL FACTOR

Inositol has important relationships to cholesterol and fat metabolism. A constituent of an important class of phospholipids, Inositol is one of the lipotropic agents which help to regulate the metabolism of fat and cholesterol in the animal body. ARGO® Inositol is now available in both 50 and 100 pound containers.

Send for your copy of the booklet ARGO® INOSITOL

Chemical Division

CORN PRODUCTS REFINING COMPANY
17 BATTERY PLACE • NEW YORK 4, N. Y.

designed for the professional...

LEITZ ***LABOLUX*** MICROSCOPE

Scientists, physicians and technicians who must work for long periods with a microscope will appreciate the new Leitz LABOLUX with its *fatigue-free operation, precision optics* and *unexcelled dependability.*

- Stage—instead of tube—moves for focusing.
- Individual coarse and fine adjustments are combined in a single, clutch-operated control knob.
- All controls including those for the mechanical stage in low position for fatigue-free operation.
- Can be used facing away from observer, for greater accessibility of all controls.
- Pre-aligned substage illuminator or mirror.
- Retractable spring mounts in objectives prevent damage to lens and slides.
- Inclined binocular body tube interchangeable with monocular tube for photomicrography.

Send for ***LABOLUX*** brochure *today.*

See and examine the new Leitz ***LABOLUX*** microscope soon.

E. LEITZ, INC., 468 FOURTH AVENUE, NEW YORK 16, N.Y.
Distributors of the world-famous products of Ernst Leitz, Wetzlar, Germany
LENSES • CAMERAS • MICROSCOPES • BINOCULARS

E. Leitz, Inc., Dept. SC-3
468 Fourth Ave., New York 16, N. Y.

Please send me your brochure on the new Leitz ***LABOLUX.***

Name _____

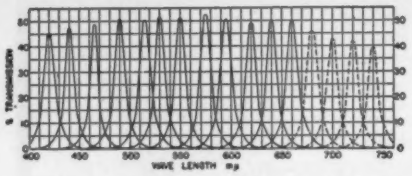
Street _____

City _____ State _____

G.A.B. Interference Filters

(Made in Switzerland)

for isolating narrow spectral bands



Spectral Range: 400-900 millimicrons
Spectral Width: 12-15 mμ, Transm.: 45-50%
Size: 2" x 2". Other sizes on order.

For

Flame Photometry and Color Densitometry
Microscopy and Photomicrography
Colorimetry and Fluorimetry

also in reflectometry, light scattering measurements, microcolorimetry, refractometry, polarimetry, and in all other fields requiring monochromatic light in the visible and near-infrared range.

Write for Bulletin #180 to

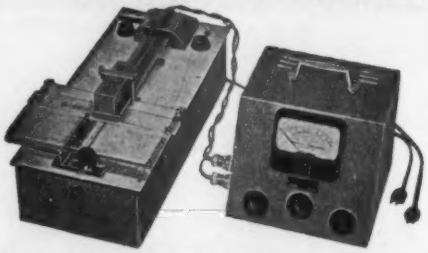
PHOTOVOLT CORP.

95 Madison Ave. New York 16, N. Y.

PHOTOVOLT Densitometer

for

Partition Chromatography and Paper Electrophoresis



A photoelectric precision instrument for the rapid and convenient evaluation of strips and sheets of filter paper in partition chromatography and paper electrophoresis

Write for Bulletin #800 to

PHOTOVOLT CORP.

95 Madison Ave. New York 16, N. Y.

Also: Colorimeters | pH Meters | Multiplier Photometers | Fluorimeters | Nephelometers | Interference Filters

More Precision in Air Conditioning

Niagara "Controlled Humidity" Method provides air at precise conditions of temperature and moisture content.

In the range from below 32° F. to 140° F. you may have constant conditions within tolerances of 1° F. and 2% R. H. with control by thermostats alone... simple and inexpensive... no moisture sensitive instruments needed.

This Method uses "HYGROL" liquid absorbent to remove moisture from the air directly. Operation is automatic; the absorbent is re-concentrated, by a new, reliable method, at the same rate as it becomes diluted.

Use it for drying processes, preventing moisture damage to instruments or hygroscopic materials, controlled atmospheres for tests and experiments. Unit capacity ranges up to 20,000 c. f. m.

Write for Bulletins No. 121, 122, address Niagara Blower Co., Dept. SW 405 Lexington Ave., New York 17, N. Y.

MORE CONTRAST

Announcing the

"ANOPTRAL"

PHASE CONTRAST EQUIPMENT

by Reichert-Wilska

A new method of light microscopy to achieve

- Far greater Contrast than ordinary Phase
- Optimum Resolving Power
- Elimination of Stray Light

The Anoptral Phase Contrast Equipment consists of four special objectives, a condenser of high numerical aperture and auxiliary microscope and can be employed with most standard microscopes.

WILLIAM J. HACKER & CO., INC.
82 BEAVER ST., NEW YORK 5, N. Y.

SCIENCE

AAAS EDITORIAL BOARD

Dael Wolfle
Acting Editor

Charlotte V. Meeting
Assistant Editor

Mark H. Adams — Bentley Glass
William R. Amberson — Karl Lark-Horovitz
Wallace R. Brode — Edwin M. Lerner
William L. Straus, Jr.

Advertising Representative: F. A. Moulton

Society of Protozoologists

SINCE their discovery by Leeuwenhoek, some 20,000 species of protozoans have been described. They occur in practically all habitats where life can exist and are among the first links of the food chain on which all higher life depends. Floating in the plankton of tropic seas, they cause the luminous glow of waves and ship-wakes. Blooming off our coasts, they cause the red tide which deposits windrows of dead fish on shore. They abound in ponds and streams and in the soil. Their role in sewage purification is just beginning to be understood. Their skeletons cover the ocean floor and form the chalk we use in teaching.

As parasites, protozoans play a double role. Malaria is still the world's most important disease. Trypanosomiasis has interdicted vast African grazing lands for livestock. Amebas cause dysentery in man, and coccidians cause it in his domestic animals. But other protozoans, packing the termite's hind-gut almost solidly, digest the cellulose that it eats and feed it with their wastes and their dead bodies. Fabulous numbers of protozoans swarm in the paunch of cattle and sheep and in the cecum and colon of the horse, but their role there is still unknown.

Some protozoans appear deceptively simple, others fantastically complex. Yet even the morphologically simple ones are physiologically complex. The human parasite, *Entamoeba histolytica,* looks like little more than a blob of protoplasm with a nucleus, but it has still not been cultivated free of other living organisms.

Because of their unique characteristics, protozoans are remarkably rewarding research subjects. They are studied for their own sake by taxonomists, physiologists, and others, and partly for the sake of their hosts by parasitologists. More and more in recent years students of higher animals and plants have turned to them when confronted by problems difficult to handle in multicellular organisms. Because of their small size and rapid rate of reproduction, many individuals can be obtained at low cost. This makes protozoans excellent subjects for genetic, ecologic, and other studies. And they offer a challenge to students of metabolic pathways who are weary of bacteria and are looking for new fields to conquer. They are ideal subjects for the study of comparative nutrition, since almost every kind of nutrition is represented in the phylum.

The backgrounds and interests of the persons who work with protozoans are so different that they are often unfamiliar with what their confreres are doing. More important, they are often unaware of the value of their confreres' work for their own investigations. Parasitologists, for example, can pick up ideas applicable to their own work from studies reported on free-living protozoans.

In recognition of this, the Society of Protozoologists was organized in 1947. Its objectives are closer association of workers in protozoology and the advancement of protozoology. It now has about 450 members and has held six meetings in association with either the American Association for the Advancement of Science or the American Institute of Biological Sciences. The society also began publication of a quarterly journal, the *Journal of Protozoology,* in 1954.

The society is compiling a list of the protozoans maintained by research workers throughout the world and is assembling information on methods of cultivation, optimal growth conditions, isolation procedures, and so forth, for each species and strain. Information on about 750 strains has already been gathered and is in process of compilation. Undoubtedly many persons are carrying protozoan cultures that are not in this compilation. They are invited to write to the secretary for blank data cards so that their cultures can be included.

As a final footnote, the Society of Protozoologists is one of the few that recognize the graduate students' financial status. Their dues are two-thirds those of other members, but their rights and privileges are the same.

NORMAN D. LEVINE, *Secretary,*
Society of Protozoologists
College of Veterinary Medicine
and Agricultural Experiment Station,
University of Illinois, Urbana

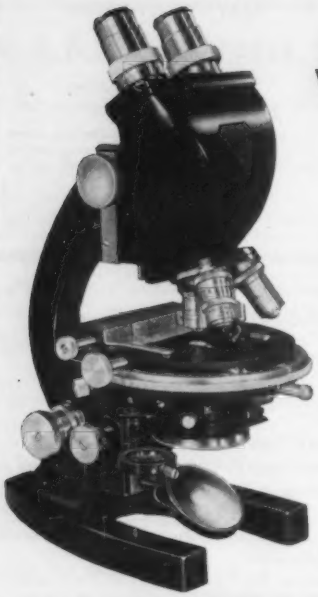
SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. SCIENCE is indexed in the *Reader's Guide to Periodical Literature.*

All correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D. C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors.

Change of address: The notification should reach us four weeks in advance. If possible, please furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including postal zone numbers, if any.

Annual subscriptions: $7.50; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, 50¢. Single copies 25¢. Special rates to members of the AAAS. Cable address: Advancesci Washington.

The AAAS also publishes THE SCIENTIFIC MONTHLY.



A Bausch & Lomb Research Microscope ...standard of science ...will help you to:

1. Eliminate fatigue in prolonged observations
2. Save valuable time
3. See the most detailed images known to optical science
4. Cover the widest range of visual and photomicrographic study

BAUSCH & LOMB

SINCE B&L 1853

When do YOU need a

RESEARCH Microscope?

When your work entails lengthy, intensive examination of microscopic specimens, you'll welcome the relaxed ease, freedom from fatigue, and appreciable savings in time that you enjoy with a Bausch & Lomb Research Microscope. Your hand rests on the table for strain-free operation of fine focus, stage and substage controls. You'll find it easier to orient specimens, even in petri dishes, with the graduated, rotatable circular stage; easier to locate repeat settings precisely for quick future reference.

When your work requires the most critical possible observation—visual or photomicrographic—the combination of apochromatic objectives, 1.40 N.A. achromatic substage condenser, and compensating eyepieces, provides maximum resolution . . . sharpest contrast, finest detail . . . for detection of otherwise hard-to-see materials and structures. Images are brighter, clearer, because all optical elements are Balcoted to reduce reflection and flare, to transmit full illumination. A complete range of eyepieces, objectives, substage equipment, and stages permits ready adaptation for the most difficult specialized studies, with choice of bright field, dark field, polarized light or phase contrast.

See for yourself, in actual demonstration in your own laboratory, why you and your work will benefit from a Bausch & Lomb Research Microscope.

Write for demonstration and Catalog D-1010. Bausch & Lomb Optical Co., 64261 St. Paul St., Rochester 2, N. Y.

RESEARCH MICROSCOPES

WILEY BOOKS

GENERAL PHYSICS, A Textbook for Colleges, Second Edition

By the late Oswald Blackwood, formerly of the University of Pittsburgh, and William Kelly, University of Pittsburgh. Includes new material on gas kinetics, nuclear energy, cosmic rays, and derivation of the potential of a point charge. *Ready in May. Approx. 720 pages. Prob. $6.75.*

An INTRODUCTION to CHEMISTRY

By Howard L. Ritter, Miami University. Emphasizes the understanding of chemistry rather than the detailing of chemical facts. A laboratory manual is also available. *Ready in May. Approx. 616 pages. Prob. $6.00.*

An INTRODUCTION to the CHEMICAL PROPERTIES of ORGANIC COMPOUNDS

By Elliot N. Marvell and Albert V. Logan, both of Oregon State College. Designed for use in non-major organic chemistry courses. Aliphatic and aromatic compounds are discussed separately. The concept of the functional group is stressed. *Ready in May. Approx. 300 pages. Prob. $4.75.*

PHYSICAL CHEMISTRY

By Farrington Daniels and Robert A. Alberty, both of the University of Wisconsin. Based on a text used in classrooms for 42 years, this book offers a completely modern presentation of physical chemistry including new developments. Fundamental principles, including derivations and applications, are stressed. *Ready in April. Approx. 716 pages. Prob. $6.50.*

PRACTICAL LABORATORY CHEMISTRY

By Horace G. Deming, University of Hawaii. Emphasizes technical skills, illustrates them through lecture experiments, and moves on to a practical explanation of chemical principles. Problems included are carefully graded. *Ready in May. Approx. 272 pages. Prob. $3.50.*

LIFE SCIENCE, A College Textbook of General Biology

By Thomas S. Hall and Florence Moog, both of Washington University. Deals with the present status of the several biological sciences. Portrays science as an activity. *March, 1955. 502 pages. Prob. $6.00.*

The CHEMISTRY of LIPIDS of BIOCHEMICAL SIGNIFICANCE

By J. A. Lovern, U. K. Department of Scientific and Industrial Research. Emphasizes the interrelationships of various lipid classes and integrates the subject. *1955. 132 pages. $1.75.*

REALMS of WATER

By Ph. H. Kuenen, University of Groningen, The Netherlands. A clear, general picture of oceanography which stresses the state and movement of water. *1955. Approx. 320 pages. Prob. $5.25.*

GEOGRAPHY of the NORTHLANDS

Edited by George H. T. Kimble, Twentieth Century Fund, and Dorothy Good, Princeton University. A new survey of the arctic and sub-arctic regions. *March, 1955. 534 pages. Prob. $10.00.*

ORGANIC REACTIONS, Volume VIII

Editor-in-Chief, Roger Adams, University of Illinois. *1954. 437 pages. $12.00.*

Send for copies today

JOHN WILEY & SONS, Inc. 440 Fourth Avenue, New York 16, N.Y.

Carworth Farms, Inc.

AKR (LEUKEMIC) MICE . . .

now available for
immediate shipment to
all laboratories.

For further information and price list please write:

CARWORTH FARMS, INC.

NEW CITY, ROCKLAND COUNTY, N. Y.

For Research In **CANCER**

NUCLEIC ACIDS, for growth studies.

YEAST ADENYLIC ACID, for its inhibition of tumor growth in mice.

PURINE COMPOUNDS, for growth inhibition studies.

N-ETHYL MALEIMIDE, for its reported antimitotic effect in tissue culture of chick fibroblast.

TRIPHENYL TETRAZOLIUM CHLORIDE, for determination of cancerous tissue.

TRIPHOSADEN® (Schwarz Brand of Adenosine Triphosphate), for phosphorylation studies.

These SCHWARZ preparations meet the exacting requirements of products intended for use in biochemical and clinical research.
Write for informative technical bulletins, complete specifications and references to literature.

Schwarz

SCHWARZ LABORATORIES, INC.

Manufacturers of Fine Chemicals
230 Washington Street, Mount Vernon, N. Y. SL 317 A

HORMONE ASSAYS

ACTH • Growth • Gonadotropes
Estrogens • Androgens
Corticoids • Progesterone
Others

HYPOPHYSECTOMIZED RATS

•

ENDOCRINE TOXICITY TESTS

Write for details

ENDOCRINE LABORATORIES OF MADISON, INC.

5001 W. BELTLINE HIGHWAY • MADISON, WISCONSIN

AAAS SYMPOSIUM VOLUME

SOVIET SCIENCE

Second Printing

Russian Genetics	Theodosius Dobzhansky
Russian Physiology and Pathology	W. Horsley Gantt
Russian Psychology and Psychiatry	Ivan D. London
Scientific Method and Social Science: East and West	Russell L. Ackoff
Russian Contribution to Soil Science	J. S. Joffe
Soviet Physics and Chemistry	John Turkevich
Soviet Mathematics	J. R. Kline
Science and Intellectual Freedom in Russia	Lazar Volin
An Appraisal of Science in the USSR	Conway Zirkle

6 x 9 inches, clothbound, 115 pages, price $1.25

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

1515 Mass. Ave., NW, Washington 5, D. C.

LARGE CYLINDERS for COMMERCIAL USE

Ample stocks in large cylinders of all gases carried at both our East Rutherford, N. J. and Joliet Ill. plants.

MEDIUM-SIZE CYLINDERS for PILOT-PLANT and LABORATORY USE

Three different sizes of cylinders containing approximately 5%, 10% and 30% of the contents of large commercial cylinders. These cylinders are designed for use on benches and in hoods and are readily portable.

"LECTURE BOTTLES"

for Research Experiments or Classroom Demonstrations.

71 different gases of highest purity are available in these little cylinders which have a diameter of 2" and an overall length of 15½".

Matheson's Complete Line of Triple-Tested

AUTOMATIC PRESSURE REGULATORS and NEEDLE VALVES

assure you of the correct type of control required for each gas.

MATHESON BULLETIN

NEW GASES NOW AVAILABLE

Extra Dry Hydrogen
Carbonyl Sulfide
Silicone Tetrafluoride
Chlorotrifluoroethylene
3-Methylbutene-1

Specialists in COMPRESSED GASES

From Acetylene to Xenon, Matheson has ***all*** the gases! Any rare or common gas, or any mixture thereof that you may need in your work is available from the Matheson Company.

Our new catalog listing the prices of 71 gases and mixtures also shows the pressure at which various gases are packed, their purity and the sizes of cylinders in which they may be obtained, as well as the proper type of pressure or flow control to be used. Write for our new price list.

THE MATHESON COMPANY INC.

EAST RUTHERFORD, N. J. • ***JOLIET, ILLINOIS***

ALL THE CHEMICALS NORMALLY USED IN THE LABORATORY are also available from

THE MATHESON, COLEMAN & BELL

Division of

THE MATHESON COMPANY

East Rutherford, N. J. Norwood (Cinna), Ohio

ORGANIC and INORGANIC REAGENT CHEMICALS

STAINS and SOLUTIONS

M C&B

INTERNATIONAL ARID LANDS MEETINGS

of the AAAS and its

SOUTHWESTERN AND ROCKY MOUNTAIN DIVISION

University of New Mexico, Albuquerque, New Mexico, April 26-29

Southwestern Field Trip, Albuquerque-El Paso and return, April 30-May 1

Featuring a **Symposium on What is the Future of Arid Lands?** Public evening lectures, April 26, 27 and 28 by Homer L. Shantz, Charles E. Kellogg, and B. T. Dickson (Australia), and Technical Sessions:

Morning, April 27—Variability and Predictability of Water Supply in Arid Regions—Speakers: Reed W. Bailey, C. W. Thornthwaite, Jean Tixeront (Tunisia), Luna Leopold, F. Dixey (England), C. C. Wallén (Sweden), John H. Dorroh, T. L. Smiley.

Afternoon, April 27—Better Use of Present Resources—Speakers: Kanwar Sain (India), R. O. Whyte (Italy), L. N. McClellan, Hilgard O'R. Sternberg (Brazil), L. A. Richards, Cyril Luker, Raymond Price, Pedro Armillas (Mexico).

Morning, April 28—Prospects for Additional Water Sources—Speakers: E. J. Workman, Edward Bowen (Australia), Sheppard T. Powell, W. F. J. M. Krul (Holland), Vincent J. Shaefer, Glenn W. Brier, H. E. Hayward, Louis Koenig.

Afternoon, April 28—Better Adaptation of Plants and Animals to Arid Conditions—Speakers: Olaf S. Aamodt, Colonel Omar Draz (Egypt), R. Merton Love, Knut Schmidt-Nielsen, Enrique Beltrán (Mexico), B. P. Uvarov (England), Michael Evenari (Israel), L. M. Pultz.

Discussion Group Sessions, April 29 (See SCIENCE of February 11, 1955, or THE SCIENTIFIC MONTHLY of March, 1956, or write to the American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., U.S.A., for details. Cable Address: Advancesci, Washington, D. C.)

Housing Reservation

International Arid Lands Meetings Housing Bureau
Chamber of Commerce, Albuquerque, New Mexico

Please send requests *directly* to the Bureau to save time. Confirmation in two weeks in order received. *Single rooms may become scarce; if possible share a twin-bedded room—and also save.* Be sure to indicate if you need a room the night of May 1 on return from the Field Trip. *Deadline for receipt of reservations,* **April 15.**

Hotels	*Single with bath*	*Double with bath*	*Twin-bedded with bath*
HILTON	$7.50	$9.00	$10.00
FRANCISCAN	5.50	6.60	9.50
ALVARADO	5.50–9.00 (only a few 5.50)	.....	8.50–12.00
EL FIDEL	4.50 (a few 3.50 & 4.00 without bath)	5.00–6.00 (a few 3.50 & 4.50 without bath)	8.00 (a few 5.00 & 7.00 without bath)
Motels (all with bath)	$4.00–$5.00	$5.00–$6.00	$7.00–$10.00

All of the above prices subject to 2% state tax.

Please reserve the following accommodations: Date of Application: .....
State name of hotel or insert "Motel" if this is your preference:
First Choice ..... Second Choice ..... Third Choice .....

.....	Single room with bath	Desired rate		Maximum rate	
.....	Double-bedded room with bath	Desired rate		Maximum rate	
.....	Twin-bedded room with bath	Desired rate		Maximum rate	

The name and address of each person, including yourself, must be listed (attach list if necessary.) .....

.....

Date and time of arrival ..... Date and time of departure .....

Mode of Transportation .....

Name .....
(Please print or type name of individual making this request.)

Address .....
(Street) (City and Zone) (State)

Enclose deposit of $10.00 (refunded if cancelled before **April 15.**)
Make checks payable to Berl Huffman, Secretary, Albuquerque Chamber of Commerce.

Registration Form

International Arid Lands Meetings
(All Registration by Mail in Advance. No fee.)

Name (Dr., Miss, etc.) .....
(Please print or type) (Last) (First) (Initial)

Academic, Professional or Business Connection and Title .....

Office or Home Address (Mail Address) .....

.....

Field of Interest .....

Probable Discussion Group Preference (by number) .....
(You will be free to change or to attend more than one.)

Field Trip Reservation (limited to first 222 applicants—deadline **April 5**)
Yes ..... No ..... ($20.00 for trip, lodging, and meals *must* accompany reservation. Refunds up to April 15.)
Send to: Dr. E. F. Castetter, University of New Mexico, Albuquerque, New Mexico, U. S. A.

"The most consistently conceived and best executed work on introductory chemistry from the viewpoint of correlation of electron structure and atomic size that has been written," reports one college professor who read the manuscript of

GENERAL CHEMISTRY

by Luke E. Steiner and J. A. Campbell

This text contains material to extend the best student, yet is written to be within the grasp of the average student. First, the merits of the "fundamental particle" idea are investigated and contemporary chemistry is then interpreted in terms of structural arrangements of fundamental particles, their interactions, and mass and energy interchanges. The development proceeds from atoms to molecules, to condensed systems, to solutions, to chemical reactions, and culminates in an introduction to the complicated systems found in living organisms, particularly man. *Ready in March*

LABORATORY MANUAL to be published with text

Ready in the Spring

"It is by far the best book on the subject that I have seen. It contains the most complete coverage of the subject matter of any books at its level, is well written, and is well illustrated," reports one physics professor who read the manuscript of

ATOMIC AND NUCLEAR PHYSICS

by Robert S. Shankland

Although the first part of this text is primarily concerned with Atomic Physics and the second part with Nuclear Physics problems, the author has unified the entire treatment throughout the text to emphasize the fact that Atomic and Nuclear Physics is in reality a single subject. Some very important original photographs of atomic and nuclear processes are used to complement the text, and many primary references are included. *Ready in the Spring*

The Macmillan Company

60 FIFTH AVENUE, NEW YORK 11, N.Y.

NOW OVER 5100
BIOS CHEMICALS

- Bixin
- Boldine
- Borocaine
- Boromolybdic Acid
- Boron Trichloride
- Boron Triphenyl
- Borotungstic Acid
- Brassidic Acid
- Bromelin
- p-Bromobenzyl Bromide
- p-Bromobenzyl Cyanide
- 4-Bromoimidazol
- 4-Bromopyridine
- Bromosalicylaldehyde
- 8-Bromotheophylline
- 8-Bromoxanthine
- Bulbocapnine
- Butyl Oleate
- Butyl Thiocholine
- Butyrylcholine Chloride
- Butyrylthiocholine Iodide
- Cadmium Arsenate
- Cadmium Borate
- Cadmium Chromate
- Cadmium Dimethyl
- Cadmium Fluoride
- Cadmium Lactate
- Cadmium Thiocyanate
- Caesium Chloride
- Caesium Fluoride
- Caesium Nitrate
- Caesium Sulfate
- Calcium Acrylate
- Calcium p-Aminosalicylate

Ask for our new complete catalogue

BIOS Laboratories, Inc.
17 West 60th St. New York 23, N. Y.
PLaza 7-8171

Biochemistry of Nitrogen

Edited by **Suomalainen Tiedeakatemia-Academia Scientiarum Fennica,** Helsinki 1955. 535 pages. $12 bound, $10 paper-covered.

This is a collection of papers on biochemistry of nitrogen and related subjects published in honour of ARTTURI I. VIRTANEN on the occasion of his 60th birthday. It contains 49 research articles in English, French or German on biochemical topics of current interest, most of which deal with problems of the biochemistry of *amino acids, proteins, nucleotides, nitrogen fixation, photosynthesis, nitrate reduction, amino sugars, etc.*

Among the 98 contributors are, *e.g.*, A. BUTENANDT, M. CALVIN, E. B. CHAIN, E. CHARGAFF, G. HEVESY, A. J. KLUYVER, H. A. KREBS, R. KUHN, R. LEMBERG, F. LYNEN, L. PAULING, M. STACEY, F. C. STEWARD, J. B. SUMNER, H. THEORELL, A. TISELIUS, A. R. TODD, O. WARBURG, C. H. WERKMAN, P. W. WILSON, and their co-workers.

Distributor:
AKATEEMINEN KIRJAKAUPPA —
Helsinki

Meetings & Conferences

April

15–16. American Mathematical Soc., Brooklyn, N.Y. (AMS, 80 Waterman St., Providence 6, R.I.)

15–16. Eastern Psychological Assoc., Philadelphia, Pa. (G. Lane, Dept. of Psychology, Univ. of Delaware, Newark.)

15–16. Iowa Acad. of Science, Davenport. (J. L. Laffoon, Iowa State College, Ames.)

15–16. Louisiana Acad. of Sciences, joint meeting with New Orleans Acad. of Science, New Orleans. (E. S. Hathaway, 1423 Jefferson Ave., New Orleans 15.)

15–16. Montana Acad. of Sciences, Butte. (L. H. Harvey, Dept. of Botany, Montana State Univ., Missoula.)

15–17. Italian Soc. of Geophysics and Meteorology, 3rd general assembly, Genoa. (I. Dagnino, 5 Via Balbi, Genoa.)

16. Committee for the Scientific Study of Religion, spring, New York, N.Y. (W. H. Clark, Hartford Seminary Foundation, Hartford 5, Conn.)

16–17. American Acad. of Optometry, 2nd Western regional meeting, Los Angeles, Calif. (D. R. E. Waters, 325 N. Broadway, Santa Ana, Calif.)

17–21. American Dermatological Assoc., Belleair, Fla. (ADA, 102 E. 78 St., New York, N.Y.)

18–19. National Air Pollution Symposium, 3rd, Pasadena, Calif. (A. M. Zarem, 621 S. Hope St., Los Angeles 17, Calif.)

18–19. Symposium on Amino Acid Biogenesis and Protein Synthesis, Los Angeles, Calif. (M. S. Dunn, Dept. of Chemistry, Univ. of California, Los Angeles 24.)

18–20. American Oil Chemists' Soc., 46th annual, New Orleans, La. (C. L. Hoffpauir, 2100 Robert E. Lee Blvd., New Orleans 19.)

18–20. National Association for Research in Science Teaching, New York, N.Y. (W. C. Van Deventer, Dept. of Biology, Western Michigan College of Education, Kalamazoo.)

18–20. Symposium on Potentialities of Women in the Middle Years, E. Lansing, Mich. (Dept. of Information Services, Michigan State College, E. Lansing.)

18–21. American Soc. of Mechanical Engineers, spring meeting, Baltimore, Md. (C. E. Davies, ASME, 29 W. 39 St., New York 18, N.Y.)

18–22. Soc. of Motion Picture and Television Engineers, 77th semiannual convention, Chicago, Ill. (K. M. Mason, Eastman Kodak Co., 137 N. Wabash Ave., Chicago 2.)

21. Soc. of Automotive Engineers Golden Anniversary, Aeronautic Production Forum, New York. (G. F. Chapline, SAE, 29 W. 39 St., New York 18.)

21–22. Eastern States Health Education Conf., New York Academy of Medicine, New York, N.Y. (NYAM, 2 E. 103 St., New York 29.)

21–23. Assoc. of Southeastern Biologists, annual, Charleston, S.C. (M. E. Gaulden, Biology Div., Oak Ridge National Laboratory, Oak Ridge, Tenn.)

21–23. Ohio Academy of Science, annual, Ohio Wesleyan Univ., Delaware. (R. W. Dexter, Kent State Univ., Kent, O.)

22. American Eugenics Soc., annual New York, N.Y. (AES, 230 Park Ave., New York 17.)

22–23. American Mathematical Soc., Chicago, Ill. (E. G. Begle, Dept. of Mathematics, Yale Univ., New Haven 11, Conn.)

Meetings & Conferences

April, *contd.*

22–23. Arkansas Acad. of Science, annual, Searcy. (L. F. Bailey, Univ. of Arkansas, Fayetteville.)

22–23. Georgia Acad. of Science, Athens. (W. B. Redmond, Box 534, Emory University, Ga.)

22–23. Nebraska Acad. of Science, annual, Lincoln. (C. B. Schultz, Univ. of Nebraska, Lincoln 8.)

24–26. American Association for the Advancement of Science, Southwestern and Rocky Mountain division, Santa Fe, N.M. (F. E. E. Germann, Dept. of Chemistry, Univ. of Colorado, Boulder.)

24–28. American Ceramic Soc., Cincinnati, Ohio. (ACS, 2525 N. High St., Columbus 2, Ohio.)

24–28. Scientific Apparatus Makers Assoc., 37th annual, White Sulphur Springs, W.Va. (J. Irving, SAMA, 20 N. Wacker Dr., Chicago 6.)

24–29. Inter-American Cong. of Radiology, Washington, D.C. (E. P. Pendergrass, 3400 Spruce St., Philadelphia 4, Pa.)

25–26. American Soc. of Mechanical Engineers, Instruments and Regulators Conf., Ann Arbor, Mich. (C. E. Davies, ASME, 29 W. 39 St., New York 18, N.Y.)

25–27. Centennial Symposium on General Education, Basic College, Michigan State College, East Lansing. (P. H. Barrett, Dept. of Natural Science, Michigan State College, East Lansing.)

25–27. National Acad. of Sciences, 92nd annual, Washington, D.C. (Secretary, NAC, 2101 Constitution Ave., NW, Washington.)

25–27. Symposium on General Education, E. Lansing Mich. (Dept. of Information Services, Michigan State College, E. Lansing.)

25–30. International Symposium on Electrical Discharges in Gases, Delft, Netherlands. (A. W. van Wagensveld, Mijnbouwplein 11, Delft.)

26–28. American Industrial Hygiene Assoc., Buffalo, N.Y. (H. F. Smyth, Jr., 4400 5 Ave., Pittsburgh 13, Pa.)

26–29. International Health Cong., Bournemouth, England. (P. A. Wells, 90 Buckingham Palace Rd., London, S.W.1.)

26–1. International Symposium on Arid Land Problems, Albuquerque, N.M. *2–4* May. Conference (by invitation only), Socorro, N.M. (J. A. Behnke, 1515 Massachusetts Ave., NW, Washington 5, D.C.)

27–29. International Conference on Nuclear Engineering, Los Angeles, Calif. (T. J. Connolly, Dept. of Engineering, Univ. of California, Los Angeles 24.)

27–29. Soc. for Experimental Stress Analysis, Los Angeles, Calif. (W. M. Murray, Central Square Station, P.O. Box 168, Cambridge 39, Mass.)

28. West Virginia Academy of Science, Fairmont, W.Va. (James T. Handlan, Jr., Potomac State College, Keyser, W.Va.)

28–30. American Physical Soc. Washington, D.C. (K. K. Darrow, Columbia Univ., New York 27.)

28–30. Midwestern Psychological Assoc., Chicago, Ill. (L. J. Cronbach, 1007 S. Wright, Champaign, Ill.)

29–30. Alabama Acad. of Science, Tuscaloosa. (H. McCullough, Howard College, Birmingham, Ala.)

29–30. Colorado-Wyoming Acad. of Science, Greeley, Colo. (O. W. Olsen, Colorado A. & M. College, Fort Collins.)

29–30. Mississippi Acad. of Sciences, Meridian. (C. Q. Sheely, Box 574, State College, Miss.)

Depend on Clay-Adams . . .

The *preferred* source of supply for leading hospitals, laboratories and teaching institutions. Quality products through leading scientific dealers everywhere. Our 216-page catalog describes 1161 products.

Clay-Adams

141 East 25th Street • New York 10

Look for these familiar trade names—your assurance of quality! Adams Centrifuges • Yankee Rotators • Gold Seal Slides and Cover Glasses • Adams Laboratory Counters • Counting Chambers Yankee Shakers • Medichromes

COMPOSITION OF SCIENTIFIC WORDS

ROLAND WILBUR BROWN
Geologist, U. S. Geological Survey

CONTENTS: Foreword; Abbreviations and Symbols; History and Nature of the English Language; Nature of Greek and Latin; Transliteration; Diacritical Marks; Greek and Latin Words; Formation of Scientific Terms; Adoption of Words; Composition of Words; Arbitrary Creation of Words; Gender; Spelling and Pronunciation; Cross-Reference Lexicon; Bibliography; Index.

This new book is designed for all persons interested in the derivation and coinage of words, but especially for scientists who need new words for new concepts. The first 61 pages describe how words are made and the remaining 821 pages supply the materials and examples for making them. The comprehensive lexicon is a two-way arrangement of English and classical items combined in one alphabetic sequence. Thus, classical roots, listed under appropriate English key words, can be found readily by the wordmaker.

* * *

An indispensable tool for the scientist!
A fine gift for an intelligent friend!

* * *

Bound attractively and sturdily in blue cloth, stamped in gold. 6" x 9", 882 pp.

Price $8.00 prepaid. Order directly from the author at U. S. National Museum, Washington 25, D. C.

Outstanding

McGRAW-HILL BOOKS

ELEMENTS OF ZOOLOGY

By TRACY I. STORER, University of California, Davis; and ROBERT L. USINGER, University of California, Berkeley. *McGraw-Hill Publications in the Zoological Sciences.* In press

Here is a skillful abridgement of Storer's very successful *General Zoology,* aimed at those courses in which a somewhat lighter book is desired. It is a shorter text, omits detailed summaries of classification and lists of references, but has expanded treatment of the physiology of organ systems. Careful attention has been given to incorporating results of recent research particularly in physiology, ecology, and evolution.

A synoptic viewpoint of the likes and differences in organ systems of animal bodies is stressed including the comparative display of organs and organ systems for each major bodily function. There is an unusually complete coverage of groups throughout the Animal Kingdom. Text material has been organized for clarity of exposition at the college freshman level. Many new and original illustrations have been provided to facilitate clear understanding of structural features and functions in animals.

GENERAL ZOOLOGY

By TRACY I. STORER, University of California, Davis. *McGraw-Hill Publications in the Zoological Sciences.* Second edition. 798 pages, $6.50

A general introductory text for colleges and universities. Part One consists of general animal biology, including structure, physiology, reproduction, genetics, ecology, distribution, evolution, history, and classification. Part Two covers the animal kingdom from Protozoa to man, describing the structure, functions, natural history, and economic relations of common representatives, and a classification of each group.

McGRAW-HILL BOOK COMPANY, Inc.

330 West 42nd Street • New York 36, N. Y.

Meetings & Conferences

April, *contd.*

29–30. New England Radio-Electronics Meeting, Boston, Mass. (C. W. Metcalf, Inst. of Radio Engineers, 52 Chauncy St., Boston.)

29–30 Seismological Soc. of America, Berkeley, Calif. (G. D. Louderback, Bacon Hall, Univ. of California, Berkeley 4.)

29–30. Symposium on Fundamental and Applied Advances in Chelate Chemistry, sponsored by Polytechnic Inst. of Brooklyn, New York, N.Y. (H. P. Gregor, PIB, 85 Livingston St., Brooklyn 1, N.Y.)

30. American Mathematical Soc., Stanford University, Calif. (E. G. Begle, Dept. of Mathematics, Yale Univ., New Haven 11, Conn.)

30. New Hampshire Acad. of Science, Hanover, N.H. (H. W. Curtis, Thayer School, Dept. of Elec. Engineering, Dartmouth College, Hanover.)

30–3. American College of Apothecaries, Inc., Miami Beach, Fla. (R. E. Abrams, 2173 Knorr St., Philadelphia, Pa.)

May

1–3. American Assoc. of Colleges of Pharmacy, Miami, Fla. (R. A. Deno, College of Pharmacy, Univ. of Michigan, Ann Arbor.)

1–3. American Soc. of Hospital Pharmacists, Miami Beach, Fla. (G. Neimeyer, 2215 Constitution Ave., NW, Washington, D.C.)

1–4. American Institute of Chemical Engineers, Houston, Texas. (S. L. Tyler, AICE, 120 E. 41 St., New York 17.)

1–5. Electrochemical Soc., Cincinnati, Ohio. (H. B. Linford, 216 W. 102 St., New York 25.)

2–4. American Geophysical Union, annual, Washington, D.C. (W. E. Smith, AGU, 1530 P St., NW, Washington 5.)

2–5. Research Equipment Exhibit and Symposium in Instrument Techniques and Applications, annual, National Institutes of Health, Bethesda, Md. (Supply Management Branch, NIH, Bethesda 14.)

4–5. American Psychosomatic Soc., 12th annual, Atlantic City, N.J. (L. S. Kubie, APS, 551 Madison Ave., New York 22.)

4–6. American Inst. of Electrical Engineers (Middle Eastern District), Columbus, Ohio. (N. S. Hibshem, AIEE, 33 W. 39 St., New York 18.)

4–6. American Meteorological Soc., Washington, D.C. (K. C. Spengler, A.M.S., 3 Joy St., Boston 8, Mass.)

5–6. Soc. of American Military Engineers, 35th annual, New York, N.Y. (F. H. Kohloss, SAME, Mills Bldg., 17th at Pennsylvania Ave. NW, Washington 6.)

5–7. American Ethnological Soc., Bloomington, Ind. (Alice G. James, Hunter College, 695 Park Ave., New York 21.)

5–7. Kansas Acad. of Science, Lawrence. (C. T. Rogerson, Dept. of Botany, Kansas State College, Manhattan.)

5–7. Illinois State Acad. of Science, Carbondale. (L. E. Bamber, ISAS, 223 Natural History Bldg., Urbana, Ill.)

5–7. Soc. for American Archaeology, Bloomington, Ind. (G. I. Quimby, Chicago Natural History Museum, Chicago 5, Ill.)

5–7. Soc. for Applied Anthropology, Bloomington, Ind. (E. Purcell, SAA, 61 W. 55 St., New York 19.)

Meetings & Conferences

May, *contd.*

6. American Assoc. of Spectrographers, 6th annual, Chicago, Ill. (F. E. Stedman, Engineering Research Laboratory, Bendix Aviation Corp., 401 N. Bendix Dr., South Bend 20, Ind.)

6. Conference for Engineers, 2nd annual, Columbus, Ohio. (H. A. Bolz, College of Engineering, Ohio State Univ., Columbus.)

6–7. Illinois Acad. of Science, annual, Carbondale. (L. E. Bamber, 233 Natural History, Univ. of Illinois, Urbana.)

6–7. North Carolina Acad. of Science, annual, Davidson, N.C. (J. A. Yarbrough, Meredith College, Raleigh, N.C.)

6–7. North Dakota Acad. of Science, annual, Grand Forks, N.D. (J. Donald Henderson, University Station, Grand Forks.)

6–7. South Dakota Acad. of Science, Brookings. (A. L. Haines, Chemistry Dept., Univ. of South Dakota, Vermillion.)

6–8. American Psychoanalytic Assoc., Atlantic City, N.J. (R. L. Frank, 745 5 Ave., New York 22.)

8–12. Soc. of American Bacteriologists, annual, New York. (J. H. Bailey, Sterling Winthrop Research Inst., Rensselaer, N.Y.)

9–13. American Psychiatric Assoc., 111th annual, Atlantic City, N.J. (W. Malamud, 80 E. Concord St., Boston 18, Mass.)

10. World Health Assembly, 8th, Mexico City, Mexico. (World Health Organization, Palais des Nations, Geneva.)

12–14. American Assoc. of the History of Medicine, 28th annual, Detroit, Mich. (E. H. Ackerknecht, professor of the history of medicine, Univ. of Wisconsin, Madison 6.)

12–14. Virginia Academy of Science, Harrisonburg, Va. (F. F. Smith, VAS, P. O. Box 1420, Richmond.)

12–19. Latin-American Cong. of Chemistry, Caracas, Venezuela. (Jose L. Prado, Edificio Industria-Puente Republica, Apartado de Correos No. 3895, Caracas.)

13–14. American Physical Soc., New York State Section, Buffalo, N.Y. (L. W. Phillips, Univ. of Buffalo, Buffalo 14.)

13–14. American Assoc. for Cleft Palate Rehabilitation, 13th annual, Boston, Mass. (A. Fox, 1653 Main St., Springfield, Mass.)

14–21. European Federation for Chemical Engineering, Frankfurt A.M., Germany. (Dechema, Frankfurt A.M. W. 13.)

16–18. Radiation Research Soc., Hotel New Yorker, New York, N.Y.

16–19. American Assoc. of Cereal Chemists, St. Louis, Mo. (C. L. Brooke, Merck and Co., Inc., Rahway, N.J.)

16–20. National Conf. on Weights and Measures, 40th, Washington, D.C. (W. S. Bussey, National Bureau of Standards, Washington 25.)

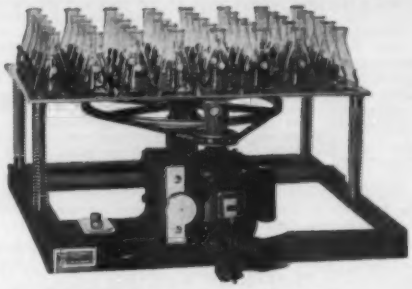
18–20. American College of Cardiology, 4th annual, New York, N.Y. (P. Reichert, ACC, 140 W. 57 St., New York 19.)

18–20. European Assoc. of Exploration Geophysicists, 8th meeting, Paris. (Dr. B. Baars, 30 Carel van Bylandtlaan, The Hague.)

19. Maryland Acad. of Science, annual, Baltimore, Md. (J. W. Easter, Mt. Vernon Woodberry Mills, Mercantile Trust Bldg., Baltimore 2, Md.)

Rotary Action

FLASK SHAKER



- Smooth operating, non-creeping and vibration free.
- Variable speed control . . . 160 to 400 oscillations per minute.
- Precision built for continuous operation.
- Versatile for experimentation, research or production.

PRICE $400.00 · · · F O B NEW BRUNSWICK, N. J.

Detailed information available upon request.

NEW BRUNSWICK SCIENTIFIC CO.

PRECISION LABORATORY APPARATUS

P. O. BOX 606 • NEW BRUNSWICK, N. J.

Just off the press: Volume 17

ANNUAL REVIEW OF

PHYSIOLOGY

contains 20 reviews and 4569 references

CONTRIBUTORS:

F. C. Mann (Prefatory Chapter)
W. S. Wilde — F. Crescetelli
J. Needham — J. H. Burn
A. B. Hertzman — D. B. Lindsley
H. Rahn — E. N. Willmer
F. R. Steggerda — S. B. Barker
K. Matthes — W. O. Nelson
D. E. Gregg — E. Zeuthen
D. R. Drury — H. J. Vonk
B. L. Baker and G. D. Abrams
R. B. Livingston and R. Hernández-Peón
W. W. Swingle and W. Kleinberg
C. H. Best, R. E. Haist and G. Wrenshall

$7.00 postpaid, U.S.A.;
$7.50 postpaid, elsewhere

ANNUAL REVIEWS, INC.
Dept. B, Stanford, California

PERSONNEL PLACEMENT

YOUR ad here reaches over 32,000 foremost scientists in the leading educational institutions, industrial laboratories, and research foundations in the U. S. and 76 foreign countries — at a very low cost

CLASSIFIED: 18¢ per word, minimum charge $3.60. Use of Box Number counts as 10 additional words.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis —provided that satisfactory credit is established.

Single insertion	**$19.50 per inch**
7 times in 1 year	**17.50 per inch**
13 times in 1 year	**16.00 per inch**
26 times in 1 year	**14.00 per inch**
52 times in 1 year	**12.50 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

POSITIONS WANTED

(a) Bacteriologist, Ph.D.; experienced in and qualified for research in bacterial physiology, antibiotics, enzymes, biochemistry; qualified to teach general bacteriology, develop courses in food and soil bacteriology; three years' industrial research. **(b) Pharmaceutical chemist;** Ph.D.; four years industrial research (synthesis of drugs); four years, director research, large company. Medical Bureau, (Burneice Larson, Director), Palmolive Building, Chicago. X

Bacteriologist, Ph.D., ten years experience in public health bacteriology and veterinary bacteriology–virology. Desires teaching and/or research or industrial research. Box 73, SCIENCE. X

Biologist. M.S., additional study in parasitology and bacteriology. 2 years instructor in Medical Parasito'ogy. Desires college teaching position in Southeast. Box 64, SCIENCE. 3/18

Embryologist: Ph.D., with teaching experience desires teaching and/or research in Embryology, histology, physiology, anatomy, zoology, microtechnique. Box 71, SCIENCE. X

Experimental Psychologist, Ph.D., male, 26, married, one child. Primarily interested in learning, perception, and personality; 2 years university teaching experience; 14 publications, 5 in press; desires academic job with research opportunities. Box 74, SCIENCE. X

Medical Technician, B.S., registered, with broad hospital and pharmaceutical background desires a position in research. Box 79, SCIENCE. X

Microbiologist, B.S.; four years experience; antibiotic assays, fermentations, germicides, mildew tests, toxicology. Very capable—desires responsible position. Box 63, SCIENCE. 3/18

Microbiologist, D.V.M., Ph.D., 30, virology, pathogenic bacteriology, medical or veterinary desires academic position. Box 69, SCIENCE. 3/18

Parasitologist, masters degree desires position in research, public health, hospital or teaching. 5 years experience in parasitology and bacteriology. Box 67, SCIENCE. 3/18, 25; 4/1

Ph.D. major: Biochemical Genetics; minor: microbiology. 4 years experience in microbiological research. Publications. Desires industrial or academic position. Box 70, SCIENCE. X

Technician, A.B. Biology. 7 years with histology, pharmacology, and hematology experience in cancer, endocrinology, nutrition, and pharmaceutical research. Desires position with academic or research institution in Northeast U. S. Box 75, SCIENCE. 3/25

Zoologist, Ph.D., 1952, cellular physiology and biochemistry, available July for academic or research appointment, south-east. Experienced in radioactive tracer, manometric and spectrophotometric techniques. Eight publications on tracer studies, oxidative metabolism and calcification. Box 80, SCIENCE. 4/1

AVOID DELAY . . . . *Cash in Advance payment*
MUST be enclosed with ALL classified ads.
See "Charges and Requirements"

POSITIONS OPEN

Abstractor: New research group of internationally prominent manufacturer has created vacancy for person interested in technical abstracting and bibliographic work in support of animal nutrition and veterinary medicine research projects. Give full details in first letter, including salary range desired. Box 76, SCIENCE. 3/25

Assistantships. Research and teaching appointments in Bacteriology. Specialized research in virology, general, pathogenic, soil, food and dairy bacteriology. Write Department of Bacteriology, Oregon State College, Corvallis, Oregon for information. 3/18, 25

Biochemist; Recent Ph.D.—biochemistry or allied field—interested in nutrition and genetic problems, needed by research department in an eastern dental school. Experience in dentistry not required but interest in dental problems desirable. Salary dependent upon experience. Send curriculum vitae, recent snapshot and other pertinent material. Box 78, SCIENCE. 3/25

Biochemist (Literature)—M.S. in biochemistry with major in biology and minor in organic chemistry to assist senior scientists in evaluation of scientific data. Research and Development Division of major Pharmaceutical Manufacturer offers advancement opportunities and liberal benefits. Outline complete education and experience. Box 59, SCIENCE. 3/18

Biologist–Bacteriologist with preferably some interest in Botany wanted by Mount Allison University, Sackville, N. B., Canada, to start September 1955. Apply W. B. Stallworthy, Department of Biology. 3/11, 18

Editorial Assistant for medical publisher, pre-med background plus editorial experience. Immediate opening. Box 72, SCIENCE. X

Experienced paint formulator, trade sales, needed by well known West Coast Manufacturer, bay area. Salary commensurate with experience. Box 81, SCIENCE. X

Psychologist: Psychology major, 22–28, with some courses in preclinical sciences, to assist senior bio-statistician in preparation of case reports of clinical investigations. Research Divison of Pharmaceutical Manufacturer offers interesting opportunity and comprehensive benefit program. Box 58, SCIENCE. 3/18

Senior Research Biochemist—Research laboratory of Eastern Pharmaceutical Manufacturer desires Ph.D. in biochemistry or physiological chemistry including broad background in basic medical sciences. Opportunity for eventual administrative responsibilities. Industrial experience helpful. Send complete record of education and experience. Box 51, SCIENCE. 3/11, 18

Teaching and Research Assistantships available graduate work applied toward M.A. or Ph.D. in anatomy. Write Paul G. Roofe, Department of Anatomy, University of Kansas, Lawrence, Kansas. 3/25; 4/1

(a) Young physician to join staff, pharmaceutical company; duties consist of establishing clinical investigation of new products, charge of all correspondence relating to new products; fluency in German advantageous although translation duties not excessive. **(b) Biochemist,** Ph.D., qualified to do research in enzymes and possibly steroid chemistry to head laboratory department, new diagnostic clinic; splendidly endowed; well-rounded research program. **(c) Organic chemist** and also pharmacologist, men with Ph.D. degrees, to direct research sections; duties include initiation of new basic research, evaluating new drugs; East. S3-3 Medical Bureau, (Burneice Larson, Director), Palmolive Building, Chicago. X

APRIL 15.
SPRING BOOK ISSUE
Send your copy in, now!

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

CLASSIFIED: 25¢ per word, minimum charge $6.00. Use of Box Number counts as 10 additional words. Correct payment to SCIENCE must accompany ad.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis —provided that satisfactory credit is established.

Single insertion	**$19.50 per inch**
7 times in 1 year	**17.50 per inch**
13 times in 1 year	**16.00 per inch**
26 times in 1 year	**14.00 per inch**
52 times in 1 year	**12.50 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

BOOKS AND MAGAZINES

WANTED TO PURCHASE . . .

SCIENTIFIC PERIODICALS and BOOKS

Sets and runs, foreign and domestic. Entire libraries and smaller collections wanted

WALTER J. JOHNSON • 125 East 23rd St., New York 10, N. Y.

BOOKS FOR SALE:

Brown, V. E. "Synopsis of Medical Parasitology"—1954 $3.75. Reviews:—Jour. A.M.A. Vol. 153, No. 17, Jan. 26, 1954; La Reforma Med., Milan, No. 31, p. 854. Bull. Pan. Amer. Sanitary Bur. W.H.O. Jan. 1954, p. 115. Archivos Medicos Cuba p. 154, 1954; Med. Jour. West Indies, 1954.

Brown, V. E. "Synopsis of Medical Entomology"—$4.50; Reviews:—Acta Med. Scand. vol. 148, p. 493; Rivista di Parasit, vol. XV, No. 3, Rome; Medical Jour. of West Indies, 1954.

order from: Dr. V. E. Brown
V. A. Hospital, Dublin, Georgia

The Author is available for teaching or research.

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, J. S. CANNER, INC. Boston 19, Massachusetts

BACK NUMBER PERIODICALS—— Bought and Sold

• Tell us what you want?—What have you to offer?

Abrahams Magazine Service Established 1889 ▶ DEPT. P, 56 E. 13th ST. NEW YORK 3, N. Y.

PROFESSIONAL SERVICES

WISCONSIN ALUMNI RESEARCH FOUNDATION

LABORATORY SERVICES

Project research and consultation in Biochemistry, Chemistry, Bacteriology and Entomology

Screening of compounds for insecticidal, fungicidal and bactericidal properties • Biological evaluation and chemical determination of insecticides • Peet-Grady and C.S.M.A. aerosol tests • Warfarin assays

Write for price schedule

WISCONSIN ALUMNI RESEARCH FOUNDATION

P. O. BOX 2059-V • MADISON 1, WISCONSIN

PROFESSIONAL SERVICES

LaWall & Harrisson

Div. S, 1921 Walnut St., Philadelphia 3, Pa.

SINCE 1870

Food & Drug PROBLEMS

PHARMACOLOGICAL - BACTERIOLOGICAL - CHEMICAL

ANALYSIS OF AMINO ACIDS AND PROTEINS

VITAMINS, MINERALS, FOODS, SPECIAL DETERMINATIONS

SHANKMAN LABORATORIES

2023 SANTA FE AVENUE, LOS ANGELES 21, CALIFORNIA

BOOK MANUSCRIPTS INVITED

Write for Free Booklet SC telling how we can publish your book. All subjects considered. New authors welcome.

VANTAGE PRESS, Inc. • 120 W. 31 St., New York 1

In Calif.: 6253 Hollywood Blvd., Hollywood 28

TRUESDAIL LABORATORIES, INC.

Roger W. Truesdail, Ph.D., President
C. E. P. Jeffreys, Ph.D., Technical Director

CHEMISTS • BACTERIOLOGISTS • ENGINEERS

Write for Brochure • 4101 North Figueroa Street Los Angeles 65, California • CApitol 4145

Applied Research Consultation Analyses Testing Charter Member ACIL

SUPPLIES AND EQUIPMENT

CONSISTENT RATS & MICE

All animals antibiotic free

BUDD MT. RODENT FARM
CHESTER, N. J.

Breeders of a recognized strain of Wistar rats and W. S. mice

POLARIMETER TUBES & ACCESSORIES

for

GENERAL, SEMI-MICRO & MICRO POLARIMETRY
HIGH TEMPERATURE, CONTINUOUS FLOW & INVERSION TESTS

Write for List PT-14

O. C. RUDOLPH & SONS

Manufacturers of Optical Research & Control Instruments

P.O. BOX 446 CALDWELL, N. J.

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

SUPPLIES AND EQUIPMENT

PARASITOLOGICAL PREPARATIONS

• high quality — low priced. *Write for catalog*

TROPICAL BIOLOGICALS • P.O. Box 2227, San Juan, Puerto Rico.

ALBINO RATS*

"From the hand of the veterinarian to research"

HYPOPHYSECTOMIZED RATS

**Descendants of the Sprague-Dawley and Wistar Strains*

•

HENRY L. FOSTER, D.V.M.
President and Director

THE CHARLES RIVER BREEDING LABS.
Wilmington, Mass.

(THIS is the EXACT SIZE RECTANGLE on the Field Finder containing over 50000 lines and indicia. They form a simple, non-marking device for the microscopist to relocate fields of interest in a slide-mounted specimen. Other advantages: Superb precision—with interchangeability; non-destructive; used by substitution.)
WRITE FOR BULLETIN

LOVINS INSTRUMENTS
No. 101-030-180
Micro-Slide
FIELD FINDER
LOVINS ENGINEERING COMPANY
SILVER SPRING, MD.

ALBINO RATS

Our mass production methods insure greatest uniformity and consistency
Price list on request
DAN ROLFSMEYER CO. ■ Phone 6-6149
Route 3, Syene Road, Madison, Wisconsin

STAINS
STARKMAN Biological Laboratory

• RARE
• COMMON
Price list on Request
461 Bloor St., W.
• Toronto, Canada

SUPPLIES AND EQUIPMENT

Dajac
LABORATORIES
Leominster, Mass.

Amino Groups in Protein
2-Hydroxy-3-naphthaldehyde
(ref.: J. Histochem. and Cytochem. 2, 29 (1954))

Acid & Alkaline Phosphatase
6-Benzoyl-2-naphthol phosphate
(ref.: Rutenberg *et al*, *ibid* in print)

FREE GBI CATALOG

Write for your copy of the new 1955 edition for reference use. It lists many ready-to-use, prepared test diets and media to save you time and tedious work.

GENERAL BIOCHEMICALS, INC.
72 Laboratory Park — Chagrin Falls, Ohio

German Cameras. Import your own. Save retailers, Importers profits. Example: Exakta, automatic Westanar F2.8 lens $139.00 (pay postman $19.00 duty). We pay parcel post, insurance, and all other charges. Similar prices on all famous makes. New 1955 production. Payment through bank and inspection method guarantees full protection and satisfaction. Price lists, (please outline your interests for our technical advisory service) and details airmailed immediately. Worldpost, Tangier, Morocco. 3/18, 25; 4/1

FLANDERS RESEARCH FARMS • • • • •

Breeders of
WHITE SWISS and DBA/2 MICE
Box 22A, Flanders, New Jersey
Phone Justice 4-7580

---

technicon MOUNTING MEDIUM
the choice coverglass adhesive with *higher* refractive index • *hardens* quickly
Sample? . . . Of course, just write
TECHNICON CHEMICAL COMPANY, INC.
CHAUNCEY, NEW YORK

SPRAGUE - DAWLEY, INC.

PIONEERS IN THE DEVELOPMENT OF THE STANDARD LABORATORY RAT.

All shipments made from our new modern, quarantined colony.

SPRAGUE-DAWLEY, INC. - P. O. BOX 2071

Phone CEdar 3-5318 — Madison, Wisconsin